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FIRE LOSSES IN THE UNITED STATES. A GRAVE NATIONAL QUESTION.

By Joseph K. Freitag

The importance of Mr. Freitag's topic needs no emphasis save that which is afforded by the San Francisco disaster, still fresh in the public mind. And yet the totals of the loss of life and property there, frightful as they seem when condensed into a single event, Mr. Freitag shows to be ***less than the regular, annual aggregate of similar losses in the United States.***

If San Francisco teaches a sterner lesson of the peril and waste of non-fireproof construction than ever was presented before, she has now the opportunity of more complete and thoroughgoing reformation in building methods than was ever offered to any American city. Should she become —as we hope she may—an example of the new order, as well as a warning against the old, even so appalling a wreck as her fire ruins now seem may bring a train of economic blessings upon the country at large.—THE EDITORS.

THE great loss of life and property which has resulted from the devastation by earthquake and conflagration of the greater part of San Francisco, serves again to bring before the American people in a most emphatic manner a civic question than which few are of greater practical importance—namely, the apparent national indifference in the United States to the enormous annual drain upon the national resources occasioned by fire losses, which is largely the result of carelessness in building laws and methods.

In judging of the causes and effects of this disaster, we must distinguish between the inevitable workings of great natural forces on the one hand, and those controllable human agencies on the other hand which, with the proper foresight for communal interests, could have prevented the larger share at least of the great losses of human life and property involved. Thus while no human agency could have prevented the seismic disturbance which was undoubtedly responsible for much of the initial disaster, this is not equivalent to saying that much of the consequent wreckage of buildings, loss of life, and also

the conflagration which so swiftly followed, could not and should not have been prevented.

It seems to be plain, judging from early accounts at least, that the principal damage from earthquake occurred to the cheaper, more poorly constructed, non-fire-resisting buildings—a class of buildings which, in any congested city area, should have been prohibited by building laws long before this, especially in a locality where earthquake disturbances were not unlooked for at any time.

Disregarding for the present the direct results of the earthquake shocks, except in so far as fire immediately resulted as a natural consequence, we are brought face to face with the ever-recurring fire hazard which obtains in all the large American cities—in fact, with the question of fire-resisting construction, or the lack of it, throughout the United States. Certainly past experiences have not been wanting to impress the great lesson of fire-waste upon the American people. Witness the great Chicago fire of 1871 in which 3⅓ square miles of buildings were destroyed, involving the loss of $190,000,000 and two hundred and fifty lives, and the wrecking of fifty-six insurance companies; the Boston fire of 1872, laying waste 65 acres with a loss of $80,000,000; the fire at Jacksonville, Fla., in 1901, with a loss of $10,000,000; the Paterson, N. J., fire of 1902, involving a loss of $8,000,000; the Baltimore conflagration of 1904, destroying 140 acres of buildings at a loss of over $50,000,000; and now the San Francisco calamity, said to approximate over $200,000,000 in property loss. Surely the list is sufficiently impressive to be taken to heart, but even these figures do not tell the whole story of our national fire waste in the United States. Many other conflagrations of lesser extent and fires in individual buildings have increased the total, year by year, until in 1904, insurance tabulations show that the total loss by fire in the United States was $230,000,000, or an average daily loss of $630,000.

In the seventies, the annual fire loss was approximately $60,000,000; in the eighties, about $100,000,000; while in the nineties the yearly figures averaged nearly $150,000,000. Or, to show even more plainly what this stupendous drain upon the resources of the country really means, take the actual losses by fire tabulated by the National Board of Fire Underwriters, and it will be found that, in the past twenty-five years, no less than $3,500,000,000 worth of property has been sacrificed to this national waste. This great total may be better appreciated if compared to this national debt of the United States, which, at the highest point ever reached, on July 1, 1866, amounted to $2,733,236,173.

It has been estimated that our annual fire loss now represents a tax of $25 per year per family of population. This loss is a total one, and it is only the great prosperity of the country and the vast national wealth which has permitted the carrying of this burden so long. If the national resources of the United States had been less, if the measure of prosperity had been less generously meted out to the country, it is inconceivable to presume that such a drain could or would be permitted with such indifference. But if the proposition were to be made to the people of the United States to increase their national indebtedness during the next twenty-five years by $4,000,000,000 or $5,000,000,000,—the fire waste which may be expected within that period from present indications—what consternation and dismay would immediately result, even though a large part of the expenditure were proposed for distinct public improvements!

To all figures of fire loss heretofore mentioned must still be added the enormous expense of maintaining fire departments, extra water supplies, and all appliances and equipment now furnished and supported for the purpose of assuaging the results, but not curing the evil. Such total annual expenses are probably not less than $150,000,000, a sum which, in itself, would go far to cure the deeper and truer cause of its being.

It is true that the modern institution of fire insurance serves so to distribute the enormous fire losses over the entire community and country that the burden of any particularly great calamity is not directly felt by the people as a whole. This is one great reason, doubtless, for the apathy displayed in regard to lessening the evil of fire waste; for if each individual realized his fractional share of the loss, the fact would be more readily appreciated that he, and not the insurance company, must ultimately "pay the piper."

There is another side, however, to the fire problem which unfortunately forces the personal relation with the individual. This is the loss of life occasioned by fire horrors, of which the burning of the Iroquois Theatre furnishes one of the more terrible examples. Thus in 1904, nearly 7,000 people lost their lives in fire casualties in the United States, a daily average of nineteen lives throughout the year, thus nearly equalling the deaths from railroad disasters in the country, where the statistics for such casualties show confessedly the worst conditions in the world.

The remedy for these great losses of life and property is not to be found in either increased insurance, or improved methods of fighting fire. Insurance is a palliative and not a cure, and the same may be

said of fire departments. Neither reaches deep enough to effect the removal of the cause, and make impossible fires of any degree of magnitude. Of course, fire-fighting facilities will always be required to cope with incipient fires, but the true underlying remedy for this great loss of life and property must lie in the *universal application* of fire-resisting methods to building construction—not in mercantile buildings in congested city areas alone, but in all schools, churches, places of amusement, hospitals, town-halls, and even in city and country residences.

For, the efficiency of fire-resisting construction varies with the *universality* of its adoption. No building can be considered as a unit, regardless of its neighbors, for as long as a modern fireproof (or fire-resisting as it is now generally called by fire protectionists) building stands in the midst of highly dangerous inflammable neighbors, just so long is the term fireproof a misnomer, and highly misleading to the layman who thinks that, because termed "fireproof," the structure is therefore proof against all fire damage to itself or to its contents. This was well exemplified in the Baltimore fire, where the structures which had been built after fire-resisting methods were found to have been gutted by fire, and to have sustained great damage, although still standing and capable of being re-used, at least as far as the essential structural portions were concerned. But it must be remembered that no building erected of the materials which Nature has given us to use can be designed or constructed to withstand conflagration at its height.

Fireproof buildings must stand in fireproof cities, for each added example of fire-resisting construction contributes just so much to the bulwarks protecting all. We know by ample experience that buildings can be and are being constructed which will safely withstand all that can reasonably be expected of them as to fire-resistance—namely, that under any ordinary conditions they will safely confine fire within the edifice or compartment where it originated, or safely exclude fire from any exterior hazard of not too great intensity. Their ability to fulfil these conditions has been fully demonstrated, both by buildings threatened by destruction from without where the construction has prevailed against the attack, and in other cases where the fire-resistance of the structure served to confine an otherwise dangerous fire to the compartment where it originated, almost without the knowledge of other occupants of the building. But individual examples are not sufficient. The practice of fire-resistance must be so universal in building construction that no conditions

could result in the spread of fire beyond the original premises, or at least beyond immediate neighbors. Both the Paterson and Baltimore fires plainly demonstrated the ability of adequate fire-resisting structures to obstruct even conflagration in its path.

It is both interesting and instructive to compare fire losses in American cities with cities of England and Europe where fire-resistance has been plainly recognized as a public necessity for centuries past.

In New York, Boston, Philadelphia, the annual number of fires has been steadily increasing, and in far greater proportion than the growth of population. The same conditions hold true in London, Berlin, and Paris; but whereas the total American losses have increased out of all proportion to city growth or expansion, fire losses in Continental cities have not materially increased. The annual fire loss in Boston is now about $1,500,000, while in an average European city of equal population the fire loss will be found seldom to range over $150,000. And this is in spite of the fact that the daily number of fires will be about the same, and in spite of the usually marked superiority of American fire-fighting facilities. The real reason for the difference is to be found in the methods of building construction. While American cities have permitted the erection of "fire-traps" on every hand, Continental municipal regulations limit the height and area of buildings, the character of the building materials, and generally enforce adequate fire-resistive construction throughout all city buildings.

By referring to the Special Consular Reports made in 1892 to the State Department of the United States giving fire and building regulations in foreign countries, it will be found that in such cities as Havre, Rouen, Milan, Rome, Brussels, Antwerp, and Leeds, Sheffield and Bristol in England, every fire in the year 1890 was confined to the building in which it originated; while in Dresden, Florence, Vienna and other cities, every fire was confined to the *floor* on which it originated.

In Hamburg, out of a total of 682 fires in 1890, 659 were confined to the floor where they started, 669 to the building, while only 10 fires extended to the adjoining property. A conflagration, or the extension of fire beyond the immediately adjoining property, had not been known since 1842. And we must bear in mind that many of these results are obtained in spite of what Americans would consider the most ridiculous fire-fighting facilities. Thus in Rome, where,

in 1890, 328 fires were practically all confined to the *room* of the origin, the following description of the extinguishment of fires was given by Consul-General Bourn:—

"Buckets and fire extinguishers are chiefly used for extinguishing fires. If these are not sufficient, small hose, perhaps of 1¼ inches in diameter, are brought into service. But the force of water in many parts of the city is not great, although the supply is very abundant. If the hydrant pressure is not sufficient, small portable fire engines are used, and in cases of great emergency there is one steamer; but as it is so seldom required, no proper arrangements exist for bringing it into service. The last time the steamer was called out it was over two hours before it was ready to throw water on the fire."

Or, again, take the fire record of 1890 in the Spanish city of Malaga, amounting to but $5,000, with a population of 135,000 persons. The entire fire department was most primitive, about equal to what would be found in a small American town say fifty years ago, yet the prevalent mode of building of brick, stone, and iron, with heavy fire-walls between all buildings, has accomplished this most insignificant fire loss.

Naturally, the scarcity of lumber for building purposes, and its consequent high price, has had much to do to bring about this status of building methods; while in the United States lumber has been available, cheap, and most readily adaptable to building uses. But fortunately, in this respect at least, lumber has been steadily advancing in price until some grades have increased as much as 150 per cent during the past few years, while steel, brick, stone, cement, and the clay products have been gradually decreasing in price, until there are good commercial as well as civic reasons to hope that the hitherto Utopian accomplishment of universal fire-resisting construction may soon replace the era of jig-saw and wood-frame. Independent of the added element of security against fire, fire-resisting construction of proper materials will be found to be cheaper in the long run, decreasing repairs and insurance premiums, giving immunity from vermin, reducing the transmission of sound, and proving warmer in winter and cooler in summer than the older non-fireproof methods. At present prices, adequate fire-resisting construction may be estimated about 10 per cent dearer than ordinary methods of building; but as the deterioration of a well-built example of the former type has been estimated to be but one-tenth of 1 per cent a year, while that of an ordinary wood-joist structure is nearly 4 per cent a year, this initial difference is soon overcome.

It may be objected that the previous argument in favor of fire-resisting construction is all very well on general principles, but that it has no direct bearing upon the catastrophe at San Francisco, because, in this instance, the loss was largely the direct result of earthquake. Even from the earliest accounts of the San Francisco fire, this view may rightly be disputed, for reports so far received from the stricken city tend to show that comparatively little damage was done to the modern fire-resisting buildings by the seismic upheaval. The principal earthquake damage undoubtedly resulted to the flimsy, non-fireproof buildings, which, in falling to destruction, started conflagration on every hand, through which the better buildings were made to suffer.

San Francisco has long been known as a particularly hazardous fire risk, and insurance officials have even gone so far as to say that it was only the excellence of her fire department that prevented a conflagration long since. To quote from a description of San Francisco written in 1905: "In San Francisco, for instance, there is little being done to improve the standard of construction. It is notoriously a wooden city, yet insurance rates are fairly low, because, forsooth, the fire department is so excellent. That is like extolling the advantages of a certain locality as a health resort. It may be miasmatic; yellow fever may stalk amuck; its houses and streets may be foul, but, glory be, its doctors are skilful!"

Had the construction been uniformly fire-resisting, what a different result might have followed. For it so happens that our present methods of fireproof building are, undoubtedly, the most effective possible against earthquake disturbances. Our city buildings, at least, unless they are public monumental buildings, are seldom constructed, when made fire-resisting, of solid masonry. On account of the great area occupied by the foundations and piers of the older, solid construction, on account of the added height permissible with steel construction, and also because of its rapidity of erection, nearly all fire-resisting buildings of any magnitude are now built of the "skeleton" or "cage" construction, so called because the vital steel skeleton or framework, consisting of columns, girders, and floor-beams, when riveted together partakes of the nature of a metallic bird-cage—strong, rigid, and proof against distortion. The introduction of these methods in Chicago was the direct outgrowth of the necessities in the larger American cities for centralization within limited business areas, thus requiring the extension of buildings into the air to secure added floor space. This need was also felt in San

Francisco, and as the last previous seismic disturbance of any severity in that city had occurred in 1868, the introduction of steel-skeleton buildings in Chicago and New York in the latter eighties, immediately raised the question as to whether such construction could be made safely to withstand any earthquakes to which the locality of California might be subjected. The question was much discussed by architects, builders, and structural engineers, until, in 1890, the skeleton-construction Mills building was erected in San Francisco by Mr. D. O. Mills, as an evidence of his, or his architects', faith in the efficacy of this type of building. This faith was founded on the knowledge that steel frameworks of this character can be so designed as practically to permit of bodily overturning before failing in any portion. Indeed, in very high narrow buildings, exposed to severe wind pressure, it is no uncommon thing to anchor down the windward columns against possible overturning. Hence in localities subject to earthquake, the only serious danger would be in the construction or safety of the exterior masonry walls, and this is accomplished by tying in the brick or stone-work by metallic anchors attached to the steel frame. The Mills Building was soon followed by other similar structures, until, in 1897, the nineteen-story Spreckels Building was erected, 300 feet high; and it is to be hoped and expected that later accurate accounts will show that these steel buildings were practically immune from earthquake damage, succumbing only to the widespread conflagration, caused by the demolition of inferior, non-fireproof structures.

The remedy, then, if we are ever to learn the lessons of repeated disaster, must lie first with the Legislatures of the various States, who must, sooner or later, pass general building requirements similar to those in force in European countries; and secondly with the people in the earnest co-operation necessary to the carrying out of such laws. Then will be saved to the nation these tremendous losses of life and property, insurance burdens, and the taxes necessary to maintain its too expensive fire-fighting equipments.

TRANSPORTATION IN THE PHILIPPINES.

By Lawrence E. Bennett.

An article by the same author in our preceding issue gave a general outline of the resources, needs, and special features of the Visayan group, so far as concerns the development of railways in that part of the Archipelago. The present paper brings the reader into closer touch with the country, following the personal observations and experiences of the author while on his reconnaissance surveys. Since the publication of the first installment a change has been made in Mr Bennett's relations to the railway enterprise now under advancement by the White syndicate in the Visayan Islands. On account of his wide acquaintance among native officials and with the local government system, he has been appointed special right-of-way officer and will devote his entire attention to this work for the present.—THE EDITORS

IN a preceding article, I outlined the existing railway systems of the Philippines, and the important new projects now being actively pushed to completion, together with the harbor works which will enormously increase the business importance of the seaport terminals. It was while engaged on the harbor works in the port of Iloilo that notification arrived of my commission to go over the ground of the proposed railroads for the interests represented by J. G. White & Company and associates. I was, in short, to make a reconnaissance survey with a view to reporting on the field as affording opportunity for railroad development.

Considerable familiarity with Visayan natives and a more or less comprehensive knowledge of their linguistic peculiarities, led me to decide that foreign escort or companions would be superfluous to my party. So I started from Iloilo on horseback, and with only my native cook and guide, my credentials, and letters of introduction. Possessed of experience in dealing with the natives, and a little tact, one may journey into the interior of these islands with reasonable assurance of meeting a hospitable reception, and dependence may generally be placed upon the native officials for generous co-operation in one's enterprise. Knowing the state of affairs, I had no hesitancy in traveling alone.

So much for the matter of personal safety. On my travels in these islands I was nevertheless destined to meet with surprises in my

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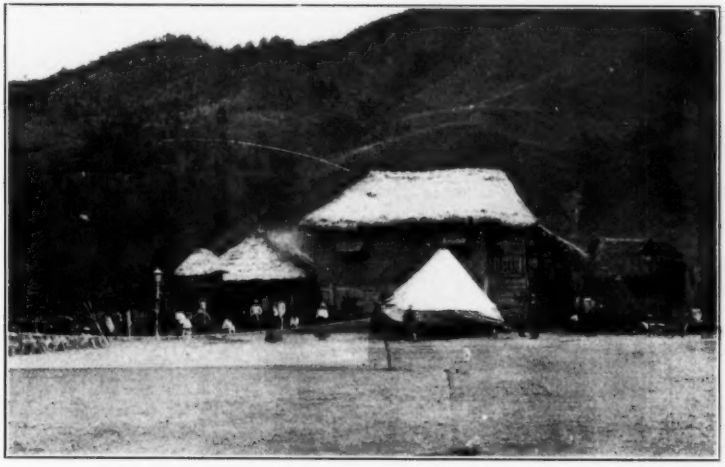
RAILWAY TRAVEL ON THE MANILA & DAGUPAN ROAD.

intercourse with the natives. Accustomed to the projection of engineering enterprises in China, where such proceedings often meet with systematic opposition, if not with open hostility, it was a pleasant surprise to find a rural population of Asiatics welcoming with open arms the prospect of a railroad. True, their ideas on the subject were primitive, and their interest analogous to that of children expecting the presentation of a new toy, but the immediate motive was immaterial; and it will be found also in the operation of the roads that returns accrue from this impulse quite as largely as from more

logical causes. There is, even in China, a patronage of the modern steam railroad in service which is little short of remarkable. On the Imperial Railway of North China, it is an ordinary occurrence to see whole train loads of coolies riding herded together in open freight cars, under a broiling sun, the most of them apparently merely out on an excursion, with no particular objective point; riding for the fun of it. It is expected that during the initial stage of building up the freight traffic on the new Philippine railroads a large percentage of the revenue will result from the third-class passenger traffic, as is the case on the Manila & Dagupan Railroad.

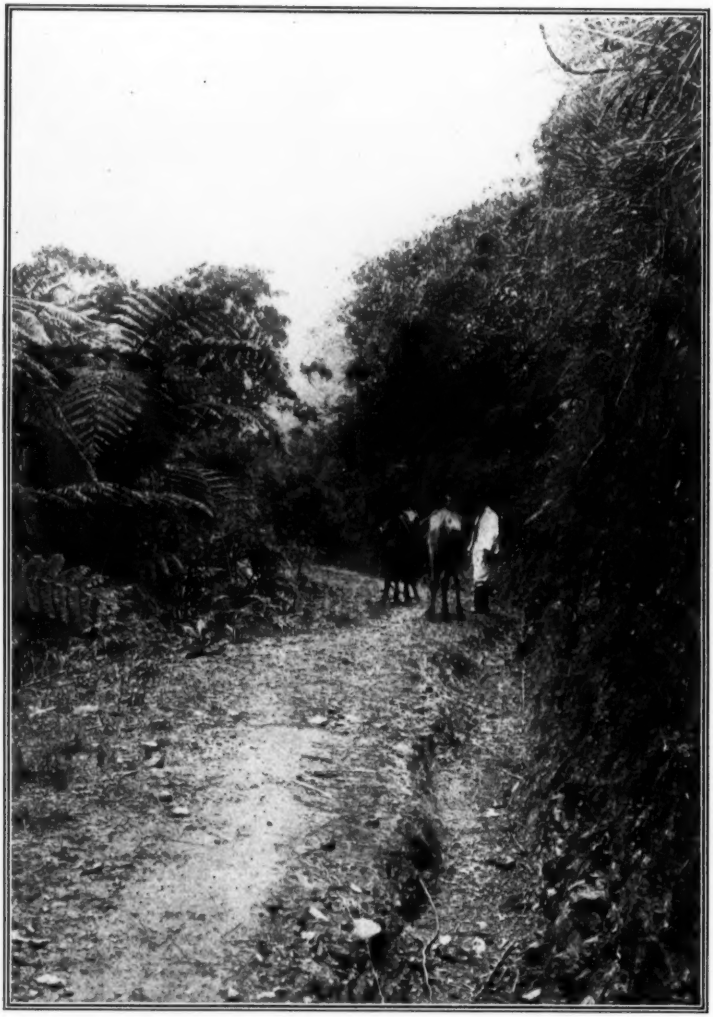


A TYPICAL LARGE PLANTATION IN THE PHILIPPINES.

Main building of the Kane-Goodman coffee plantation, Lepanto; elevation, 5,000 feet.

The first day's trip was from Iloilo to Passi, an important interior town on the proposed route in Panay. The highway along this portion is built up for a distance of thirty miles with an almost uninterrupted succession of villages, and the population would average four hundred per square mile on a strip of considerable width. The cultivated land is divided into small holdings, averaging perhaps two acres to a family, and sugar is the great staple product of the lowlands. Some of the lowland, however, is devoted to rice cultivation, while the uplands back of the main line of travel produce coffee, cocoa, hemp and other valuable vegetable fibres.

At the present time the common transportation medium is the most primitive known—the shoulders of man. The usual load for an individual is fifty pounds, and the expense of transportation to the



TRANSPORTATION IN THE MOUNTAINOUS DISTRICTS OF THE PHILIPPINES.
At the 6,000-foot level on the Bontoc-Cervantes trail.

market for the average producer is thirty-five dollars a ton during the dry season. During the rainy season, transportation there is none.

In the face of these handicaps, the small planter supports his family on the produce of two acres of land, cultivated by the most primitive and wasteful methods. It is difficult to measure the productive possibilities of this region, presuming treatment by modern practices and tools. One native told me that he was using an American disc plow and found it many times more effective than the home article—which, indeed, seems to do hardly more than scratch the surface of the ground. In the course of my journey it was discovered that this was no isolated case, for many of the more progressive farmers are taking up such innovations, and with invariable success.

At Passi, the termination of the first day's journey in Panay, I was treated to the first of a series of pleasant social intermissions which recurred occasionally throughout our expedition. Here we were welcomed heartily by the local *presidente*, when he learned my mission, and he insisted on our staying over Sunday with him. As an inducement he promised an especially attractive entertainment in the afternoon.

Nothing loth, I rested with this genial host in anticipation of the treat. This turned out to be the weekly cock fighting, of which the mayor was an ardent patron, keeping himself a large quota of game cocks. Upon my host's advice I backed his entry, a big red chanticleer, in the first bout, which proved fatal to the antagonist in less than ten seconds. In another bout, impelled by the desire to back the under dog. I spurned the advice of my mentor and selected an admittedly doubtful looking small white bird. My candidate was outclassed, as might

Courtesy of Wm. Dinwiddie, Esq.

A PRIMITIVE FILIPINO INDUSTRY.

The copper-smelting furnace is charged with fragments in small crucibles, over which charcoal is piled.

A GROUP OF NATIVES, AWAITING EMPLOYMENT BY AMERICAN FIRMS.

have been expected; but I learned the lesson of following the advice of the chief executive of a Filipino municipality at a municipal cock main.

Cock fighting is the standard amusement in the Philippines, and an engineer undertaking large works with native labor may often insure a satisfactory outcome by regularly instituting the sport on a generous scale. Next to cock fighting, a band of music is essential; and in later operations I have always endeavored to provide these binding influences. The return on such an investment is quite inestimable.

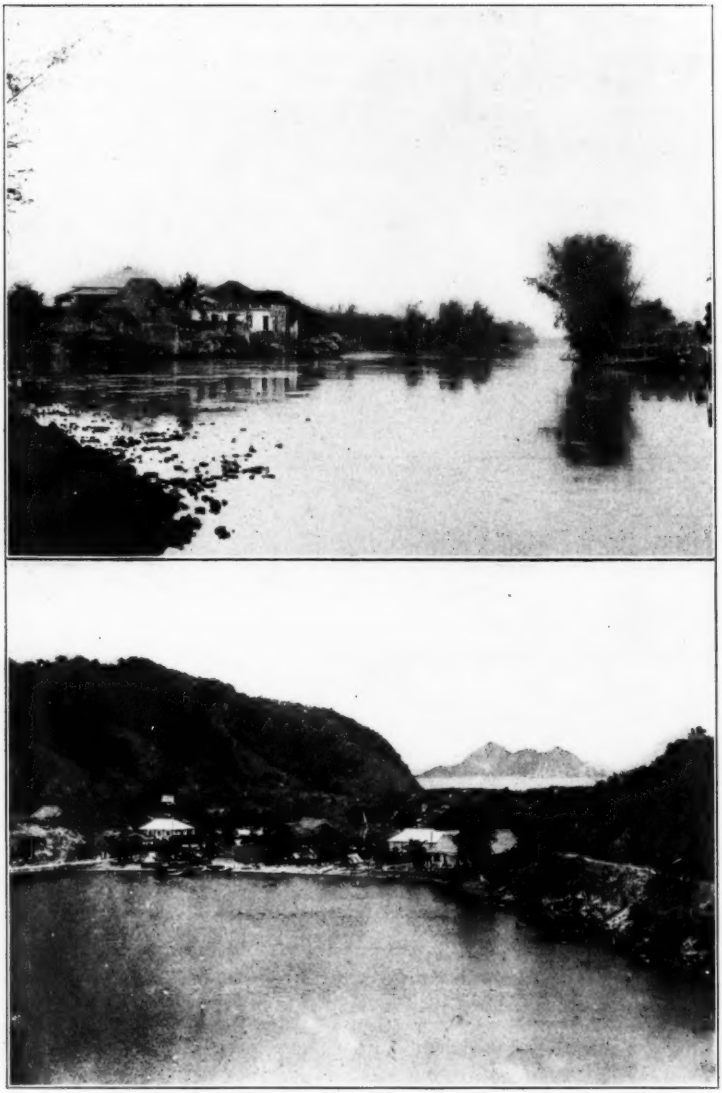
Across Panay, from east to west, forming a divide at its midsection, there stretches a range of low-lying hills, where the population is much less dense than toward the north and south coasts, and where there are wide stretches of uncultivated territory. This is apparently because of inaccessibility, for splendid opportunities are offered here for the growing of hemp, cocoanut and fruits, notably the pineapple, from the fibre of which so much of the fine Philippine *jusi*, or grass cloth, is woven. From this highland region, the land slopes right away in wide, fertile plains down to the north coast and to Bataan and Capiz, the latter of which towns is the proposed terminus of the

Panay railroad, where, with a little improvement, will be afforded excellent harbor facilities. A branch from Dao on the main line to Bataan, further west on the north coast, is contemplated. The conditions of population and agriculture which exist on the southern slope of the divide are practically duplicated on the northern. During the last twenty miles from Dao to Capiz, we were always within stone's throw of a habitation and passed through populous villages at frequent intervals. The population of Panay is one hundred and seventy per square mile, and nearly all of the six-thousand inhabitants of the island will be served by the railroad, both for passenger and freight purposes.

So far as grading and location are concerned, there will be no great difficulties imposed upon railroad construction in Panay, the country varying from a level formation, like that of the American Middle West, to moderately hilly. However, there will be some difficulty encountered in providing against washouts on the plains during the rainy season. The natural water courses are quite incapable of carrying off all the precipitation during this period, so extra culvert and bridge structures will be numerous. The bridge work in the total mileage will figure as high as three per cent on many sections of the road. It has been decided to use only concrete and steel in culverts and bridges, thus making the roadbed more stable and enduring than we are accustomed to see in pioneer construction work in the United States. This applies to the proposed roads in Negros and Cebu as well. Certainly the problem is quite different from that which confronted the pioneer builders generally in America. It is rather comparable to the state of affairs which confronted the first British and European builders. Potentially the traffic is right there now, to all intents and purposes, merely awaiting the carrier, so thoroughgoing initial construction is well advised.

It is estimated that $35,000 will be expended per mile of single-track road in Panay, and $30,000 per mile each in Negros and Cebu. The less figure in the latter case is accounted for by there being more certainly defined and more capacious natural waterways on the islands in question. In the matter of grading and location, however, they will present rather greater difficulties than Panay, having a smaller percentage of level country on the proposed routes.

The return from Capiz to Iloilo was made on a small coasting steamer, the General Blanco, and the trip was memorable. Every plank and stanchion in the little Blanco seemed to be ingrained with the evil effects of a long indulgence in the transportation of decom-



COASTAL AND RIVER SETTLEMENTS IN THE PHILIPPINES

The upper view shows a river village above Iloilo; the lower is a portion of the coast of southern Negros.

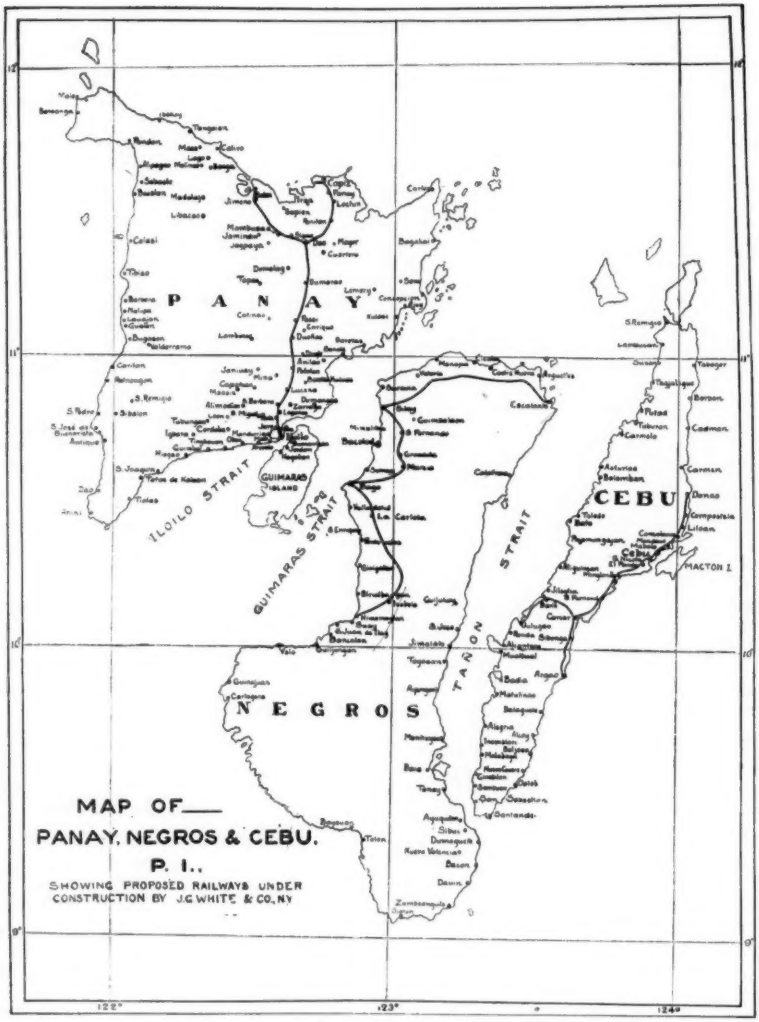
posed fish. On this particular occasion she was loaded to the gunwales with the commodity, and the sufferings of the white element in the passenger list were acute during the two days' voyage. In all my experiences of travel, I have never met elsewhere with such a nauseous odor as emanated from that little craft. I would not even except a certain steamship loaded with garlic on which I once had the misfortune to travel from Alexandria to Brindisi. One lasting result of this voyage from Capiz to Iloilo was the necessary abandonment of

Courtesy of Wm. Dinwiddie, Esq.

NATIVE WATER TRANSPORT IN THE ARCHIPELAGO.

a goodly percentage of my personal effects. In the Orient the flesh of fish is seemingly never too much decomposed for human consumption. On the Chinese railways there is a thriving traffic, from the coast inland, in fish of the skate variety. Frequently the period intervening between the catch and the actual consumption amounts to many days, under the effects of a semi-tropical climate. It is no cause for surprise, then, that the passage of a fish train generally demoralizes foreign settlements immediately along the route.

The next trip was devoted to an inspection of the railroad route on the island of Negros, which is separated from Panay by a narrow channel. Negros is the great sugar producer of the Philippines, and while its population is but 5 per cent of the total of the Archipelago, it produces half of the sugar grown. The output is now 80,000 tons annually, and adequate transportation will quadruple the figure, at a conservative estimate. The population is less than one-half that of



MAP OF THE ISLANDS OF PANAY, NEGROS, AND CEBU

Showing the railways projected and under construction. Scale about 21 miles to the inch.

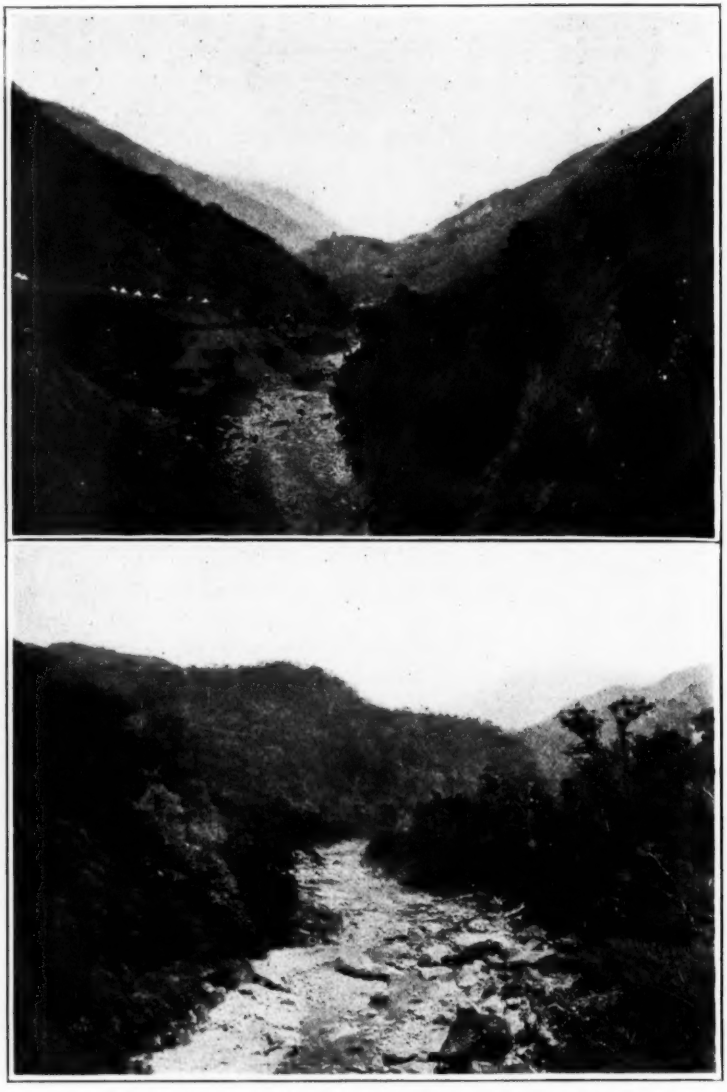
Panay and the productiveness many times greater. Of hemp, too, this island is for its size one of the best producers in the Island possessions. It is probable, then, that whereas most of the revenue of the railroad in Panay will come from passenger traffic in the initial stages, the majority of the carrying trade in Negros will be freight.

The island of Cebu, with a population of 600,000, equal to that of Panay, and averaging 350 per square mile, produces sugar in some quantity, but the main staple is Indian corn, which was brought to the Philippines from America by early Spanish settlers. On certain parts of Cebu, it gives two and often three crops per year, each crop yielding two-hundred fold. It is among the few Philippine products demanding cultivation, so statistics are quite reliable. Cebu grows more corn than the best three of the other corn-producing provinces of the Archipelago combined. On this island, then, there will be a more even division of traffic return between the passenger and freight elements.

Negros and Cebu have, besides uncultivated resources, natural ones peculiar rather to themselves. Negros abounds in magnificent timber lands, while Cebu contains the most valuable coal deposits in the Philippine Islands. On Negros there are thousands upon thousands of acres bearing a variety of wood suitable for every feature of building. The coal resources of Cebu, even in the present primitive stage of development, have made coal-distributing centers of nearly all the important towns on the east coast of the island. The quality is about like that of the Japanese product, having approximately 80 per cent of the heating value of the best American soft coal.* The product of the mines of Sibuguey Bay has been tested on vessels of the United States Navy with very satisfactory results. It is altogether probable that, in the near future, Cebu will supply enough coal not only for the demand in the Islands, but for a large part of the merchant marine of the Pacific Ocean, a factor of prime importance in determining the course of commerce in the Orient.

The island of Negros is of volcanic formation and it is the volcanic ash in the soil which accounts for its superior sugar-raising qualities. As contrasted with the nature of land tenure in Panay, the cultivated area of Negros is held in large plantations, many having an area of two-thousand acres; still, the restriction of meagre, inefficient transportation facilities is quite as potent in one field as in the other, and Cebu is in precisely the same predicament.

*The coal deposits of Batan Island were described at length in an illustrated article by O. H. Reinholt, in The Engineering Magazine for January, 1906.



TYPICAL ROUGH AND MOUNTAIN COUNTRY IN THE PHILIPPINES.

The upper view shows the Bued River gorge from the Zig-zag trail, Benguet Road. The lower illustrates a mountain stream, and shows the impossibility of marketing the abundant timber by ordinary modern logging methods.

The terminals of the Negros line will be Jimamailan, on the west coast, and Escalante, on the northeastern, both thriving trade centers. A range of mountains forms the backbone of the island, extending from near the northern end and culminating midway in the semi-active volcano Canlaon, located near the middle, northeast of Jimamailan. The railroad will skirt the western slope of this range and bend round the north end to Escalante.

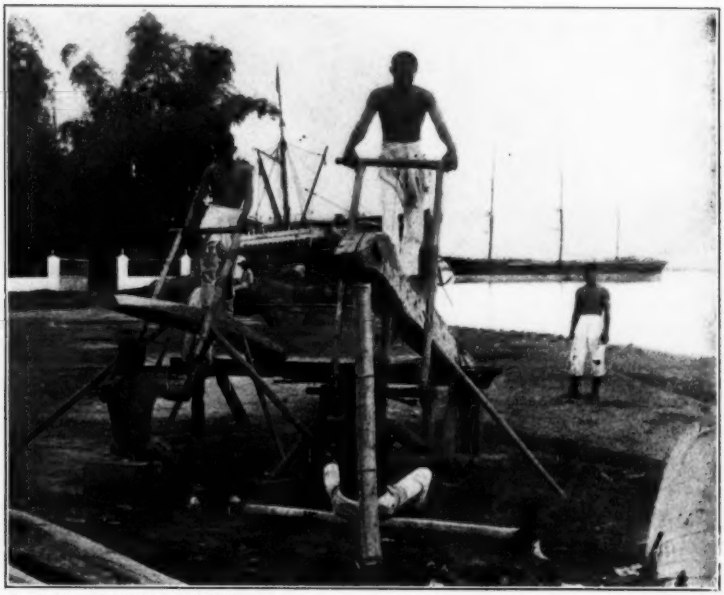
We ascended the lower slopes of the volcano for prospecting purposes, and from the vantage point thus gained had a splendid view of the extensive forest tracts of interior Negros. The foot-hills and lower slopes are grown over with great, broad-leaved tropical trees, standing so close together that their branches interlock. From these trees come the fine Philippine hardwoods largely sought for interior work in building, and for engineering works where durability is the prime consideration. Generally these woods are extremely heavy. At many points there are broad areas of pure growth of the *lauan*. The quality of this species is peculiar. Very few varieties of tropical trees grow uninterspersed in this way. Moreover, for structural purposes the *lauan* is an excellent substitute for the white pine, possessing the essential physical attributes of that wood. The scope of the timber resources of Negros is thus seen to be quite comprehensive.

At present a very small quantity of this timber is marketed. Logs are snaked out, after falling, by means of carabaos and are then floated down to the coasts on various small streams. This is a long and tedious process because of innumerable snags and sand bars. Moreover, most of the hardwood must be kept afloat by means of bamboos. Undoubtedly, logging railways would be more economical for logging operations on a large scale than flotation, and it is probable that spurs will be built from the main trunk line in Negros for this special purpose. The report of the Philippine Forestry Commission on the resources of the Islands is not yet completed, but general figures already derived indicate that the standing timber aggregates one million million board feet, or more than double the amount in the States of Washington and Oregon combined. The stumpage alone of this timber is worth nearly three-billion dollars to the Government, quite aside from the indirect benefit which will be imparted to the country through development by private vested interests. Of this immense forest reserve, a considerable portion is in Negros—probably a greater quantity than is contained in any other province of the Philippines.

At the present time, nearly all of the structural timber used in the Islands and on the China coast is imported from the Pacific coast of

the United States, at a freight rate which more than doubles the original cost of the cargo. Despite these prohibitive conditions, fortunes are being made in the import timber trade by foreigners in China. Herein again the imminent revolution of China—imminent in the light of National age—bears directly upon the welfare of the Philippines, for the single serious defect in China's array of potential wealth is the comparative lack of good building timber.

In Negros as in Panay a cordial reception was almost invariably



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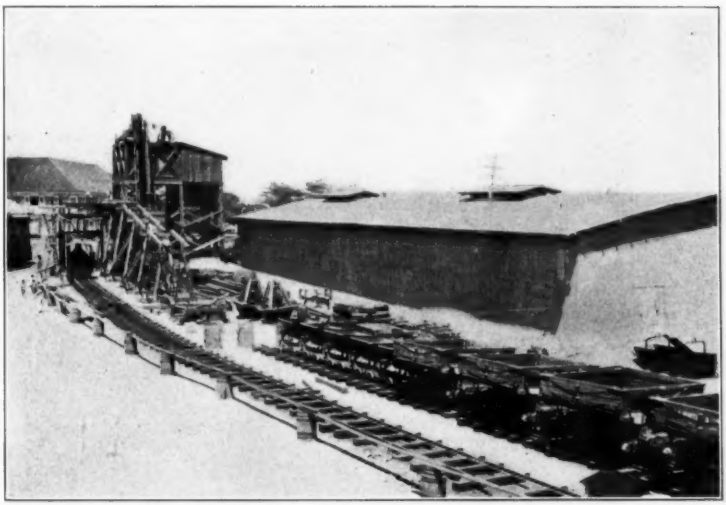
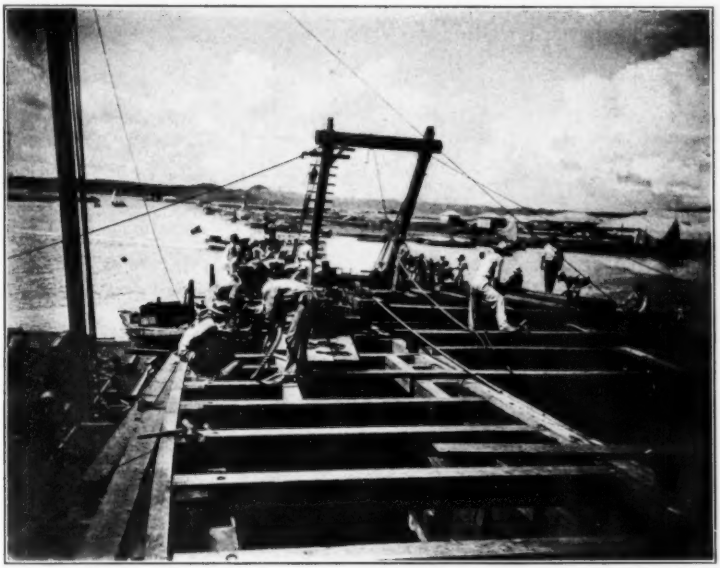
A FILIPINO SAW MILL, IN THE ISLAND OF CEBU.

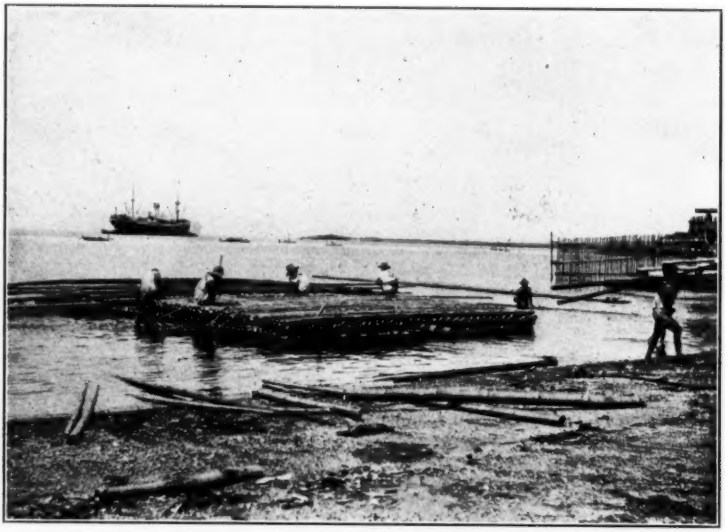
accorded us by the local native officials, but at La Carlotta we met with a rather disconcerting rebuff. However, the circumstances were peculiar. We had been traveling all day in a drenching rain and arrived at La Carlotta after dark, very effectually masked with mud, both men and beasts. In this state we unthinkingly presented ourselves in the stygian darkness at the house of the *presidente,* wherein were many signs of a *fiesta* progressing. Upon our knocking, festivities ceased and the lighted windows were framed with the inquiring, half-alarmed faces of the inmates, who, observing a ruffianly looking



THE BEGINNINGS OF THE NEW ERA. CONCRETE-MIXING PLANT, CEBU.



NATIVES ERECTING A LARGE SUCTION DREDGE AT ILOILO.



BUILDING A BAMBOO RAFT WITH RATTAN LASHINGS FOR USE ON CEBU SEA-WALL CONSTRUCTION.

A "Blue-Funnel" Liner is lying in the offing.

BUILDING A CONSTRUCTION RAILROAD AT ILOILO, ISLAND OF PANAY.

For hauling rock, sand, and gravel for the sea-wall and jetties

crew, quickly put out the lights and "played possum." We finally found refuge in the house of an American teacher.

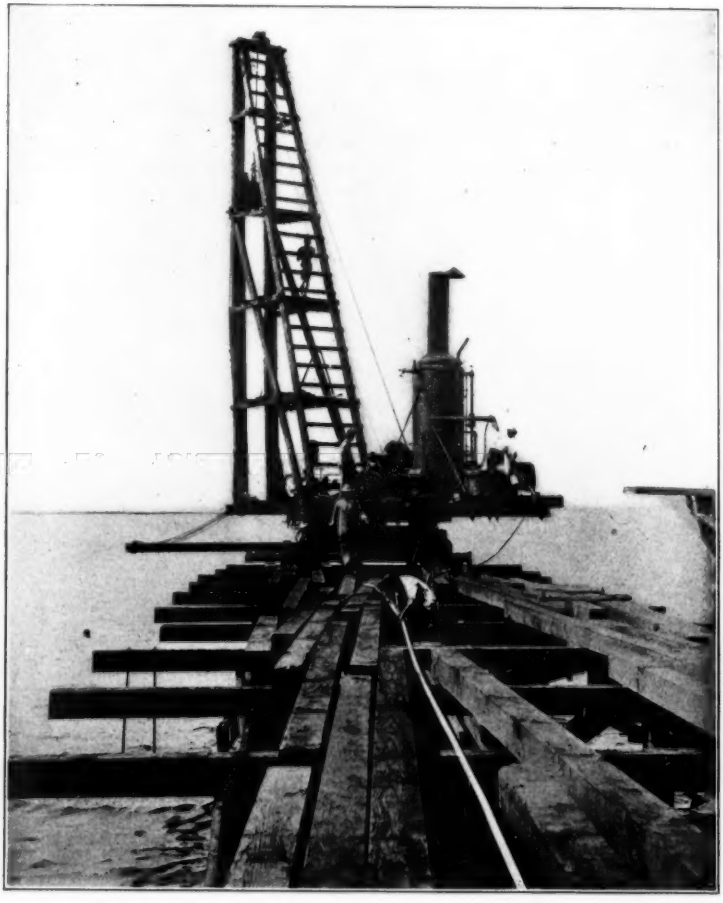
The next day was Sunday, so we rested, and in the evening our considerate host introduced me at the planters' club. The club house was attractively furnished and equipped with all the essential attributes of the Far Eastern municipal club. The representative citizens of La Carlotta, gathered here, testified in several ways to the development of the town. They showed a nice discrimination between certain brands of Scotch and American whiskey, played ably at poker, and swore precisely in English. However, the flourishing condition of many of the large plantations bore witness to the possession of stable virtues on the part of their proprietors. With suitable governmental encouragement, modern agricultural methods would doubtless be immediately accepted and instituted.

Upon completion of the inspection of Negros, we rested at Esca-

THE LONGSHOREMEN OF THE EAST. LOADING CASCOS WITH RICE AT A PHILIPPINE PORT.

lante, the port of Danao. Here is afforded one of the finest harbors in the southern islands. There is a bar at the mouth, the dredging of which presents no great difficulty. Within, there is a deep anchorage which will easily accommodate ten or twelve large steamers.

On Cebu the route of the railroad will be along the east coast from Argao, the cable port at the south, to Danao at the north. The



NATIVES OPERATING A REVOLVING PILE-DRIVER, ILOILO HARBOR WORKS.

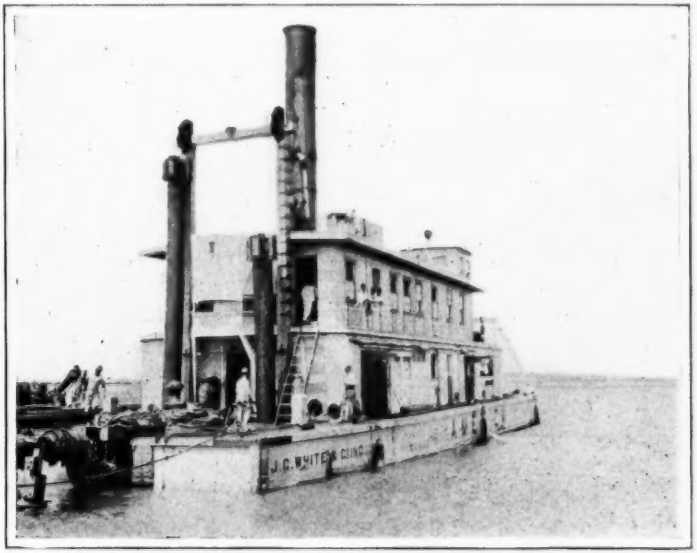
town of Cebu, the metropolis of the southern islands, is located on the line about 25 miles from the northern terminals. This line, while near the coast for its entire length will fulfil about the same service as those on Panay and Negros. There are practically no harbor facilities *en route* except at the towns mentioned, where produce must be collected for shipment.

It has been determined that a 3-foot 6-inch gauge will be used, but otherwise the precise nature of the equipment of these new railroads

is as yet problematical. The passenger-traffic demand would seem to be for two classes of passenger coach. Except as to gauge, the first-class passenger cars will probably not depart radically in appointment from the best accepted practice in the western world. The practicability of a second class on the system appears doubtful. The third-class cars will differ from the first in the elimination of finished ornamentation and upholstery.

The freight-traffic demand seems to prescribe cars of moderate capacity, especially in Panay. There are so many small farmers that shipment in small lots will probably be quite heavy, heavier than in large consignments during the early development of traffic.

The character of the motive power cannot be decided upon without a more minute investigation of the conditions on the ground.



THE DREDGE AMERICA. AT ILOILO, JANUARY, 1906.

Then, even, it will be a matter of supplying the equipment in accordance with the demand.

The steam-railroad service of Japan at the present time is the prototype of what may ultimately be expected of the traction developments now being inaugurated in the Philippine Islands. When the pioneer phase has been consummated, there will be established a sys-

MAKING MANILA ROPE IN A NATIVE ROPE-WALK.

tem conforming in all particulars, except those of size and speed, to the best modern railway practice of the western world. Because the Filipinos are a small race, cars built to the narrower gauge are to them quite as commodious as we find our own standard-gauge. The comparison is already exemplified in substance by the Japanese railways, which are narrow-gauge. On the new Philippine lines speed will at first be very moderate, but will, of course, be subject to the constant acceleration characteristic of railroad practice in general.

MACHINERY FOR THE PANAMA CANAL—OLD AND NEW.

By Fullerton L. Waldo.

Settlement of the long-debated question of the type of canal to be built across the Isthmus will bring into immediate and most active interest the choice and installation of the mechanical equipment for the vast work of excavation. Mr. Waldo's notes and pictures are fresh from the field of recent work on the Canal.—THE EDITORS.

ONE of the most pathetic sights at the Isthmus is the decaying French machinery—the eight or nine dredges and flotilla of launches, said to have cost the preposterous sum of $22,000,000, run amuck at the "Bone Yard" near La Boca, where the Rio Grande meets the line of the canal—the steam shovels of obsolete model rotting in the jungle on tracks that are mere wisps of rust—the little top-heavy Belgian locomotives disgorging orchids at their cab-windows, with bell and whistle long ago muffled by *bejucca*-vines, and lizards sunning themselves along the footboards. A prying child can poke his finger through the iron-rust in many a place, and the footfall of a gibbering monkey crashes through the dry-rot in the wooden superstructure of machinery that in its day devoured clay banks and regurgitated like some great fire-breathing dragon of ancient fable.

At La Boca there is a dredge that cost the French $250,000. The Canal engineers have decided it is not worth the $100,000 it would take to put it again into commission. As you go in a little launch from Colon to Bohio along the silted-in quarter of the Canal dug (1884-1888) by an American company in the service of the French, tugs stranded at the bankside with their decks awash and funnels canted dangerously tell the same story of lavish expenditure which ultimately served no useful end. Much of the French machinery, Mr. Morison suspected, was built simply that it might be sold to the gullible; nobody knows, today, how it was used, if indeed it was ever used at all.

All railroad track laid by the French company was laid with the light Belgian rail, 3¾ inches wide at the base and 4⅞ inches high, in 6-metre lengths. The relaying of the main line of the Panama Railroad by the Commission with 70-pound per-yard rail (as compared with 50-pound) in 33-foot lengths, is just about completed. The engineers at Culebra resurrected from the jungle fifty-

"OFF AGAIN."

eight of the Belgian locomotives and put them in commission. Nine hundred and eighty French dump cars were overhauled. In many cases it was necessary to build tracks into the jungle to fetch them out from where they stood overgrown with creepers, the original roadbed having been reclaimed long since by tropical Nature. The Commission has been economical; it has utilized every bit of the old French machinery that could be used; the repair shops at Cristobal, Bas Matachin, Empire, and Culebra have repaired a lot of it. A large dredge left at Cristobal was reconstructed and put in commission; at La Boca a 300-yard self-propelling barge was re-built,

MACHINE SHOPS AT GORGONA.

as well as a 300-ton lighter and two 55-foot steam launches. Before the new steam shovels began to be delivered on the Isthmus, many of the old French excavators of the chain-and-bucket type were reconstructed and successfully operated. The last French excavator at Culebra was discarded June 16, 1905. By June 30, nineteen of the new American steam shovels were at work. The French excavators had in clay attained a daily output of nearly 1,400 cubic yards, but according to the records of the Commission their performance in rock has not been so satisfactory as that of the American shovels.

The equipment purchased by the Commission and contracted for, for delivery not later than June 30, 1906, includes:—

1,100 steel flat cars	$1,071,100
120 locomotives	1,367,000
43 steam shovels	493,600
18 unloading machines (plows, etc.)	151,794
3 water tanks and towers	36,050
3 earth spreaders	23,382
2 dipper dredges	205,000
Miscellaneous	2,074
Total	$3,350,000

In their entirety, the more important machinery items of the original order, for preliminary work and permanent plant are as follows:—

Ocean steamships	2
Steam shovels	61
Locomotives	120
Flat cars	1,300
Dump cars	324
Rapid unloaders	12
Unloading plows	22
Earth spreaders	13
Dipper dredges	2
Steel barges	11
Stone-crushing plants	2
Air-compressing machines	14
Cranes	3
Rock drills	152
Portable deep-drilling machines	30
Hoisting engines	12
Dumping wagons and other vehicles	135

The approximate total cost of purchase of these and other items was $9,000,000.

The sixty-one steam shovels, the three wrecking-cranes, and one pile-driver, were built by the Bucyrus Company. Thirty-two of the shovels are 95-ton; twenty-eight are 70-ton; one is a so-called New-45. Two of the wrecking-cranes are 75-ton, the other 100-ton. The 95-ton shovels carry a 5-yard dipper, and, with their incisive teeth, are admirably adapted to handle the hard, indurated clay of the benches of the Culebra cut. The report of the Commission says (p. 296):—"The operations of the shovels have been entirely satisfactory, and they have already proved themselves to be machines of high efficiency. Indeed, the results so far attained indicate that there is no other type of machine better adapted to the class of work to be done in the summit cut, or which can reach a greater efficiency." The bucket-and-chain shovels of the French required a great deal of blasting. The 95-ton American shovels, despite the occasional strata of hard clay (there is no granite on the Isthmus) handle the Culebra

MACHINERY, OLD AND NEW, ON THE LINE OF THE CANAL.

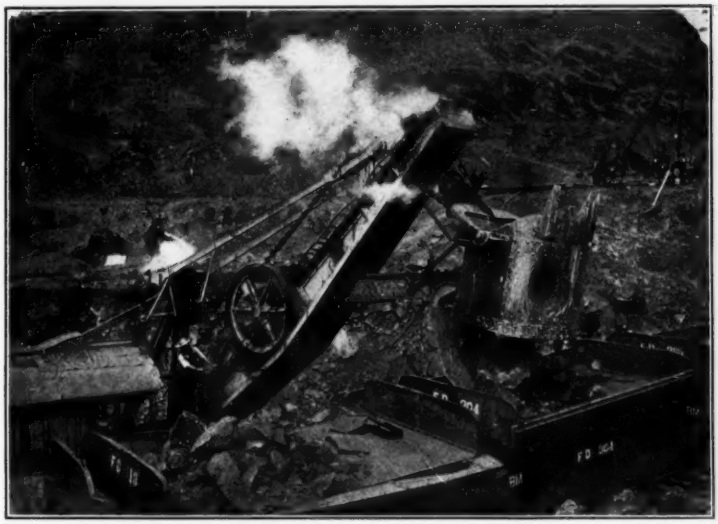
Both scenes are at Paraiso. The lower one represents old and abandoned French excavators; the upper shows American steam drills at work in February of this year.

STEAM SHOVELS WORKING ON THE CANAL.

Both views were taken in February, 1906—the upper one at Empire, the lower at Bas Obispo.

material with a comparatively slight amount of assistance from the dynamite candle.

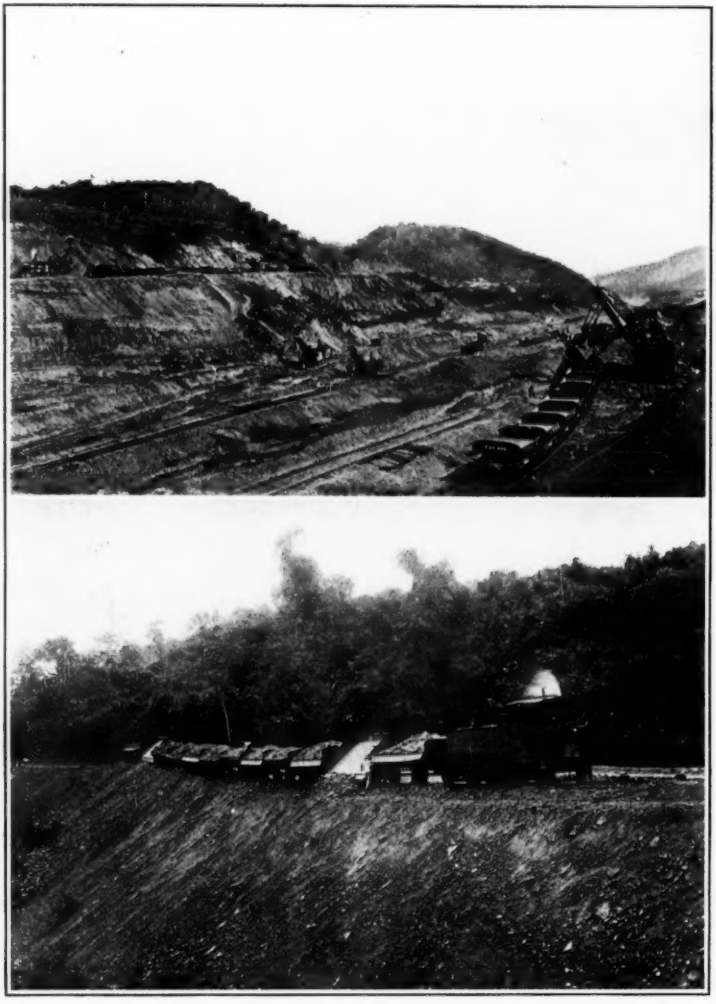
The 70-ton shovels have 3-yard dippers and are used largely in minor cuttings along the line of the Railroad. The New-45 type has a 1¾-yard dipper, and because of its superior mobility is employed on wash-outs, which are embarrassingly frequent in the rainy season. The wrecking cranes and the pile driver are just like those used by the railroads in the United States. The 95-ton shovels and the 125-ton crane are the most powerful machines of their respective types that have ever been constructed.



THE BUSINESS END OF A 95-TON STEAM SHOVEL

Main engines have 14 by 16 in. double cylinders; independent reversible engines control the thrust motion of the boom and the swinging gear; locomotive boiler, 14½ ft. by 66 in.; clear lift from rail to bottom of dipper door, open, is 17 ft.; width of cut at 8 ft. elevation is 62 ft. Car is 41 ft. 7 in. by 10 ft., with four 20-in. I beam sills; two propelling chains, for forward and rear trucks.

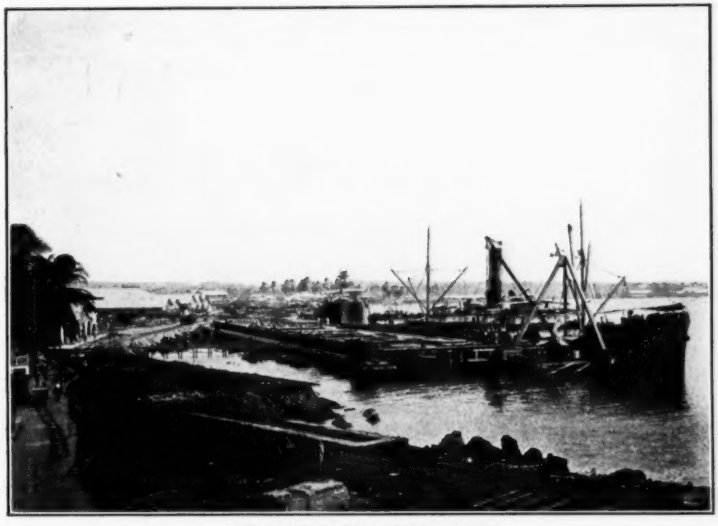
A moving crane on Dock 14 in Cristobal and a stationary crane on Dock 11 have recently been installed and are doing excellent work in dredging on the channel. Dock 11 is used by the very largest ships, and each dock accommodates two vessels. Two hundred and fifty feet of dredging will give a 27-foot channel alongside the docks. Under the French *régime*, much of this sort of dredging was done with gross carelessness or reckless extravagance. For instance, a



A GLIMPSE OF PRESENT WORK AT THE CULEBRA CUT.

The upper view shows some of the shovels installed in the great cut; the lower is one of the dumps.

locomotive stood simmering on a siding at Colon, in charge of a caretaker who didn't know a throttle from a bell-rope. "I want to dredge there!" yelled the engineer of the dredge in the channel brandishing the boom and rattling the hoisting-chain to scare away the fellow on the locomotive. The caretaker refused to budge—probably because he didn't know how to move the locomotive. With an oath, the dredge engineer attacked the bank; the man on the locomotive jumped to the crumbling and caving-in red clay; and presently the locomotive was a ruin under the teeth and claws of the dredges as the siding—rails, embankment and ties—slid into the stream with their costly burden of highly specialized machinery.



AMERICAN DOCKS AT CRISTOBAL.

Some of the dredges during the French era made a practice in dredging the clay of throwing the spoil from the excavation directly beneath themselves, so that it all had to be rehandled, at a vast profit to the contractors. That is the great trouble with most of the digging the French did—they dumped the dirt on the spot, like a child digging holes on the beach, instead of taking the trouble to convey it to a distance. They used dump-cars opening on one side only, which entailed endless inconvenience in switching. In wet weather the clayey material sticks to the French cars, and has to be shoveled out by hand. Though we are using many of these French

ONE OF THE BELGIAN ENGINES WITH A MODERN DUMP CAR.

dump-cars at present, we are supplanting them as fast as possible with the Western dump-cars everywhere in use for similar purposes in the United States. It is probable that much of the work will be done later by loading the spoil on flat cars and plowing it off.

Of the smaller machinery used in the all-important work of making borings to determine areas of probable feasibility for the location of dams, a resident engineer in charge writes the author:

"In getting borings the diamond drill was used in almost every case. The wash rig equipment consists of a tripod derrick with a wheel drum. Hollow wash rods (1⅞ in.) were used for drilling, through which water was forced by Rumsey or Gould 2½-inch hand pumps. For cutting, a bit was used with four jet holes. In clay or clayey soil it was often possible to run the rods down without casing, but for diamond-drill work, and in sand or gravel, 2½-inch casing was used and set into the rock to cut off the flow of sand or outside material. The diamond drill was the ordinary tripod machine, with 1 5/16-inch bit set with six to eight carbons, cutting an annular ring so as to leave about a 1-inch core. Usually three wash rigs and one diamond rig were running. For the river work, two rafts were built of balsa wood. . . Whenever it was possible, platforms were built in the river with old rails, and were quite serviceable, as this made it possible to use the diamond drill. It was found risky to use the diamond drill from the raft. The 2½-inch casing furnished was in some instances very carelessly threaded, and often so far out of center that the female thread which broke was often but one millimeter out of a total pipe thickness of 6 millimeters. At least six holes were lost by the casing twisting off, as it was often not easy to detect the defect."

The great trouble up to the present has been, succinctly put, that requisitions for machinery and men qualified to use it have not been

ONE SIDE OF THE CULEBRA CUT.

A RUNAWAY STEAM SHOVEL.

honored—tools and track implements have been stored in Government warehouses instead of being put into the hands of the men in the field—entirely too much dependence has been placed by the Government on the prospect of using the rotten and obsolete mechanical *transmittenda* of the French Panama Canal Company, a prospect encouraged by an exaggerated notion on the part of the Isthmian Canal Commission as to the value of the machinery.

AN ARMY VIEW OF AMERICAN GOVERNMENT ENGINEERING.

By Major Wm. L. Sibert, Corps of Engineers, U. S. A.

Major Sibert's discussion, like Mr. Waldo's just preceding, bears closely upon the leading topic of engineering interest—the practical construction of the Panama Canal. In the cause of fair play, we are glad to present this view of the efficiency of Government control of engineering construction as it appears to its friends. And in this connection we would point out that the system ably defended by Major Sibert is very close to that which we have always advocated for the Panama Canal—the commitment of the actual work wholly to contractors, under Government-prepared specifications and under Government inspection. Every instance of success he cites is an argument for the extension of the same common-sense policy to the larger work now about to enter upon its most active phase.—THE EDITORS.

HAVING noted in one or two periodicals a tendency of late to criticise the methods followed by the Government in carrying on construction work, such criticism citing, in particular, the river and harbor work of the United States—a work prosecuted by the engineer department of the Army—I feel it only fair to that department and to the Government that the people and the engineering profession should have some data upon which to base an unbiased opinion upon this question.

It should be stated in the beginning that there are no political offices in the engineer department at large. All of the employees in that department enter it in accordance with civil-service rules and regulations, and such rules and regulations are carried out by men in sympathy with their intent. It should also be stated that the river and harbor improvement in the United States is done almost entirely by the contract system. Occasionally work of some magnitude is carried on by hired labor. This, however, is the exception and not the rule. The law requires that contracts be let to the lowest responsible bidders and gives the contracting officer the right to cause the lowest bidder to establish his ability, both financially and otherwise, to do the work.

The corps of engineers referred to above built all permanent fortifications for the defense of the harbors of the United States, and it is thought that the character of this work will speak for itself in the next war, if any attempted naval invasions of such har-

bors occur. As to the river and harbor work, it is thought the fact that the navigable capacity of the great harbors of the country has kept pace with the increasing commerce entering such harbors, is forceful evidence of duty well done by those responsible for such improvements. The successful planning and constructing of the ship channel in the connecting waters of the Great Lakes, including the St. Mary's Falls and the St. Clair Flats canals, have resulted in the greatest freight movement on any inland waters in the world, and have made possible the present wonderful steel and iron development in the Pittsburg district and on the Lakes. Such rivers as the Monongahela and Great Kanawha have been completely improved, and the amount of commerce, 12,000,000 tons annually on the Monongahela and over 1,000,000 tons annually on the Kanawha, does not seem to indicate inefficient management of such improvement. The improvement to the entrance to Galveston harbor, increasing the usable depth of that harbor from 9½ feet to 27½ feet, in consequence of which Galveston has become the second or third city in the United States in the value of material exported, speaks for itself. It is thought that an examination of the above works and of many other similar works, and of the lighthouses along the shores, will cause such works to be placed among the better grade of achievements of the engineering profession throughout the United States.

While it is true that the system followed in a considerable portion of this work has been rather "hit and miss," this system cannot be charged to any branch of the executive department of the Government, the duty of such department being to execute the laws enacted by Congress. Neither can the system be charged to the River and Harbor Committee of Congress, nor to Congress itself. Committees of Congress study carefully the particular lines concerning which they recommend legislation, and are nearly always ahead of Congress itself. It is thought by those who have had the opportunity to judge that this is particularly true of the River and Harbor Committee, which has labored hard to eliminate unworthy projects and to provide funds to carry on properly the great river and harbor works of the country notwithstanding adverse, and sometimes selfish, public opinion. Congress must conform to public opinion. The system, therefore, as defined by the laws enacted by Congress, is the product of public opinion, and if the system be faulty, the newspapers, the magazines, and the people generally are responsible. Those who criticise most the faulty system are many times the first to denounce a proper River and Harbor Bill as a "pork barrel."

There are many important river and harbor projects throughout the United States. To carry on the work of all of them in a systematic and businesslike way would cause a material increase in the appropriation carried by the River and Harbor Bill—a greater increase, indeed, than public opinion at present would permit. In fact, public opinion, if retrenchment is necessary, always says, first, "cut out the River and Harbor Bill;" it always says, second, "make it of such and such a size;" which means that it is impossible to carry on the various pieces of work under way in a businesslike manner.

After a proper system has been determined upon and the necessary funds for carrying out the work in accordance therewith have been provided, the agency responsible for its execution is properly chargeable with any neglect or delay, and not until then.

The laws, and the rules and regulations framed in pursuance of laws, governing the expenditure of public funds, are drawn especially for the purpose of preventing any government employee, responsible for the plans of the work or for the disbursement of public moneys in connection therewith, from having an interest in any contract involving the execution of such work, or from having an interest in any firm furnishing material for such work, or from accepting a commission for supplies of any kind purchased in connection with such work; and it is thought that these laws and regulations should be as they are, so as to prevent in the future, as they have so well in the past, the above evils. Beyond this, it is doubtful whether there is as much red tape connected with the transaction of the business of the engineer department at large as there is in some of the great corporations of the country. This, of course, assuming that a man wants to do business with the means available, and is not looking for technical difficulties to block his work. If he is looking for such difficulties he can find them in the engineer-department methods as well as in those of private corporations.

Actual examples constitute the best data upon which to base an intelligent opinion, and the writer having personal knowledge of the following, cites them as samples of work practicable under the methods of the department in question.

The last River and Harbor Bill, approved March 3, 1905, contained, among others, the following appropriations for river and harbor work in the Pittsburg District:

First.—An appropriation of $500,000 with authority to enter into contracts for $1,281,376 more for the completion of Locks and Dams Nos. 2, 3, 4 and 5, Ohio River. Knowing beforehand from the Com-

mittee reports that this money would probably be appropriated, the designs for the work in question had all been worked out and forwarded to the Chief of Engineers for action prior to the enactment of the law. Such designs were forwarded by the district officer, through the division engineer, to the Chief of Engineers. They were passed upon, probably in amended shape, subject to an appropriation by Congress. The district officer received notification on March 15, 1905, of the passage of the River and Harbor Bill, and was called upon for a proposed scheme of execution. This was forwarded to the Chief of Engineers, through the division engineer, on March 21, 1905, and returned approved on March 28, 1905. All the contract work involved in the expenditure of the above money, that would take more than two seasons to accomplish—working seasons on the Ohio River being short—was advertised on March 17, 18, and 20, 1905; bids opened on April 17, 18, and 19, 1905; contracts entered into on May 4, 6, and 24, 1905. After that, of course, the execution of this work by the contractors would be the same, whatever the agency directing the work. The money was appropriated on March 3, 1905, the district officer notified March 15, 1905, all the contracts let and work commenced on May 24, 1905.

Second.—Improving Monongahela River, building Lock and Dam No. 3, $200,000 appropriated, contracts authorized for $389,196 more. Notification of the appropriation was received on March 15, 1905. This was a new piece of work to be built for the purpose of replacing an old lock above that was in poor physical condition. The work was urgent, since about 10,000,000 tons of freight passed through the old lock each year. It was necessary in this instance to purchase land, obtain a clear title, and have the same passed upon by the Attorney General before any work could start. A deed was obtained on May 16, 1905, and forwarded to the United States district attorney, the delay being due to the many mortgages on the large tract of land of which this property was a part. It was forwarded by the United States district attorney to the Attorney General's Office in Washington on May 22, 1905, passed upon by that office May 25, 1905, the assistant attorney general having been informed as to the urgency of the work. The work was advertised on April 27, 1905, bids opened May 27, 1905, and contract entered into on June 21, 1905. After that the rate of prosecution was dependent upon contractors working under the contract.

Third.—For building Dam No. 2, Allegheny River, and completing the lock, for which work contracts were authorized aggregating

$281,226.63. Notification of the authorization was received on March 15, 1905, work advertised on March 17, 1905, bids opened April 17, 1905, and contract entered into on May 2, 1905. These constitute the main items of new work authorized in the Pittsburg district by the River and Harbor Bill approved March 3, 1905. Other work was of course being done in pursuance of contracts authorized before that date.

If the methods of doing business in the engineer department at large permit in one district the placing of work under contract in the time specified above, they do in all; and it is thought that few of the larger corporations of the country have methods of administration that would permit placing the above and similar work under contract in less time. The regulations require, in the general case, an advertisement of 30 days, in order that everyone who desires may have an opportunity to bid. The above examples seem to indicate that an officer directly in charge of work in the engineer department can do practically anything necessary for the proper prosecution of his work so long as he is honest in his intentions and is trying to further the best interests of the Government. When a plan and project have been approved by the chief of the department, the district officer is then practically free in their execution, being governed, of course, by the laws and regulations drawn for the purposes referred to previously in this paper.

The ordinary routine of the work is carried on by the district officer directly with the Chief of Engineers. The division engineer is an intermediary only as to plans, projects, and primary methods of procedure. He is an advisory engineer, and the district officer is free at any time to call upon him for consultation or advice.

It is thought that one should be loath to conclude that the United States can not perpetuate itself—that Congress has not the wisdom to enact laws that will permit the great departments of the Government to perform in a businesslike way the functions of government, such performances being essential to progress and including the prosecution of the great works of improvement.

ECONOMICAL EQUIPMENT AND MANAGEMENT OF THE DRAFTING ROOM.

By Thomas Doane Perry.

One of our contributors said recently that the drafting room "should lead the shop, not follow it." While he was speaking rather of executive functions, the statement may be applied to administrative methods. It should certainly be a model of reasonable and common-sense system. Mr. Perry offers not only an argument for but an example of modern organization at this possible fountain-head of shop economy.—THE EDITORS.

THE need of economical management in the drafting room is a matter of increasing importance in this day of keen competition, when even the proper conversion of by-products into marketable form may be a determining factor in the dividend account. The old way of charging the cost of drafting-room maintenance against the general-expense account in a lump sum is gradually yielding to modern methods and consequent detailed analyses of such costs and systems, with a view to placing them and keeping them on an economical basis. The American tendency of going to extremes has been manifest in these analyses, and has often resulted in the compilation of expensive records which are unused and unusable. Discrimination and reason, however, are coming to be exhibited in the successful engineering and manufacturing concerns of today, and the analytical process is bringing about much needed economy in the drafting room.

The importance of starting right should be uppermost in the minds of those who are beginning their engineering career as draftsmen, that they may form good habits along these lines. Those who are organizing drafting rooms or already have them under their control should also realize the need of a systematic beginning, because there is no more serious obstacle to the establishment of economical methods than that often found in an accumulation of irregularly made and unclassified drawings and data.

The suggestions embodied in this article are outgrowths of attempts on the part of the writer and others to meet the above conditions in a practical way—i. e., to arrange and preserve systematically, and in a manner at once simple and economical, the various classes of drawings and information that accumulate in a drafting room. If

the method is such as to be serviceable for either a single draftsman or a large department, it will allow growth without such changes and readjustments as are often the cause of confusion and loss. These methods as explained have special reference to plans for machine construction, but permit of ready adaptation to most drafting-room work.

The functions of the drafting room are two; the making of working plans and drawings that shall serve as intelligent guides to the carrying out of projects in hand, and the storing and preserving of the originals of all such working drawings, together with accessory data and any preliminary sketches of value, in a form that may be easily and quickly consulted. At best the drafting room must be carried on as an expense item, and therefore should be so organized as to secure the highest efficiency at the lowest cost consistent with the fulfilment of its functions.

In view of the fact that the making can be advantageously modified to accomplish the preserving, the methods of filing and storing will be taken up first. This order of treatment will indicate more clearly the reasons for the methods suggested later in the making of drawings.

There are three methods of filing in general use: vertical, flat and roll. In times past draftsmen have been quite prone to use one to the exclusion of the others, but as a matter of fact each one is especially useful for a certain size or class of drawings.

In both vertical and flat systems of filing it will be found of decided value to group together in folders such papers as naturally relate to each other. A folder will accommodate conveniently from ten to twenty-five drawings, grouped according to some of the following systems; alphabetical, numerical, geographical, by subject, etc. A folder should be labeled clearly for convenient reference, preferably upon the projection. The projections should be about ½-inch high and one-fourth or one-fifth as wide as the body of the folder. Where subject to frequent handling these projections should be reinforced with paper, cloth, or metal. Fold-

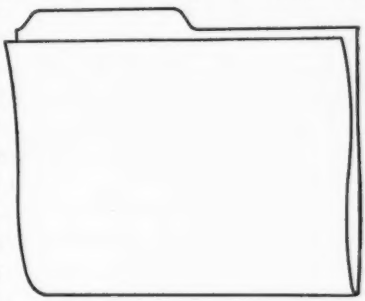


FIG. 1. FOLDER FOR DRAWINGS.

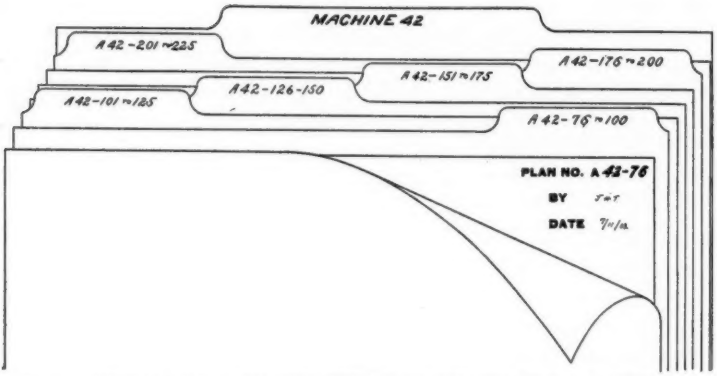


FIG. 2. VERTICAL FILING, SHOWING METHOD OF MARKING GUIDES, FOLDERS, AND DRAWINGS.

ers may be had in various colors, and this may be made the basis for a classification, such as blue for prints, manila for tracings, salmon for sketches, etc. It is usually advisable to have separate compartments for each of these classes, though in a small drafting room it is sometimes convenient to have everything pertaining to a certain set of drawings together. Folders should be made of tough stock about .01-inch thick to give necessary strength without being too bulky.

Vertical filing, a system extensively used for correspondence, is a method that may be adapted to the economical and efficient filing of plans and drawings. In brief, the method is one in which papers are grouped in single folders, such folders standing vertically on their folded edge in long drawers. Some of the features that make vertical filing valuable are: the extreme ease with which a large amount of material in a single drawer may be consulted without removal, the facility with which papers may be classified, arranged, and indexed, and the fact that there is no other method of filing known that will accommodate the same amount of material in a given cubical space. This way of filing lends itself very readily to the needs of the drafting room for everything not over 9 inches by 15 inches, and by the judicious subdivision and reduction of larger drawings a majority of them may be made to conform to the requirements of vertical filing. Each drawing should be marked or numbered clearly in the upper right-hand corner. The use of guides is necessary, and their frequency depends upon the style of classification used. It is well, however, not to have more than ten folders between guides. Guides are

somewhat higher and stiffer than folders, with a similar projection, and have near the lower edge a metal eyelet which travels on a rod in the drawer and prevents the guides from rising out of position. Stiff manila stock about .02-inch thick is generally used for guides, although the most durable are made of red fibre and called press board. The vertical filing of drawings larger than 9 inches by 15 inches is not practicable except where they are made upon very heavy board, and would require the construction of special cabinets.

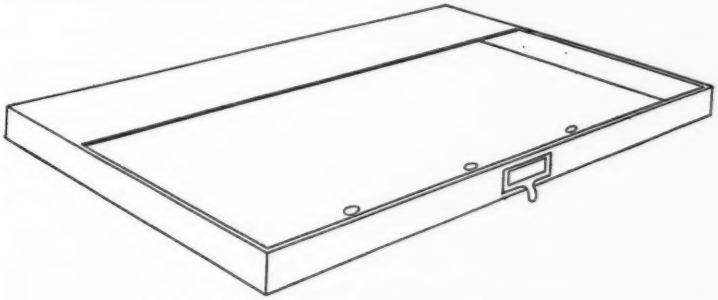


FIG. 3. DRAWER WITH HOOD AND FINGER HOLES.

Flat filing in drawers, almost universally used in drafting rooms, has its limitations. It may be made serviceable for drawings between about 9 inches by 15 inches and 32 inches by 40 inches. Of course it may be used for even smaller drawings, but is much less convenient than the vertical file. Its most serious objections are: the difficulties of keeping together such drawings as relate to each other, of removing such as may be required, of returned drawings to their proper places, and the damage to corners and edges of drawings which causes many exasperating delays. These objections may be overcome to a great degree by the addition of a few labor-saving devices. A hood over the rear 6 inches of the drawer top will do much to prevent papers from curling up over the back of drawer, and several finger holes through the drawer bottom near the front will make it easy to remove drawings, or to refer to the marks or numbers which should be in the lower right-hand corner. The sys-

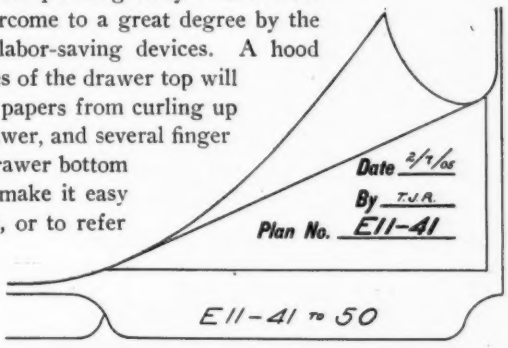


FIG. 4. HOW FLAT DRAWINGS SHOULD BE MARKED.

tematic grouping together in folders as previously outlined will be found of particular assistance in flat filing. The removal of a folder as well as its return to its proper location is an easier matter than the removal of a single drawing, and the drawings are less likely to be damaged in handling. To facilitate removal flat folders should be made of stock with a smooth surface. The folder projections, if there are only a few folders to a drawer, may be located in the lower right-hand corner; if more than half a dozen it is advisable to distribute them along the edge of the folders nearest the drawer front. Folders should be only a trifle smaller than the drawer on all sides, to prevent shaking around and the lapping of the labeled projections. The drawers should not be more than 2 inches deep. Occasionally the use of heavy press-board guides between groups of folders will facilitate the separation and finding of certain classes of drawings.

The objections to rolling, when applied to large (over 32 inches by 40 inches) drawings are not nearly so serious as in the case of smaller sizes, because a large plan can be unrolled and consulted with reasonable ease, and the construction of racks for rolls is inexpensive and economical of storage room. In fact, there seems to be no other way of accommodating such large drawings, as drawers of sufficient size would be awkward. The practice of folding drawings and filing in pockets or envelopes is a relic of the past, and is a clumsy and inconvenient method at best. In what has been said about rolling and folding, reference has been had to such original copies as are to be kept in the drafting room. The folding or rolling of prints or sketches for purposes of transportation is advisable, whenever necessary. But for working shop drawings there are obvious advantages in drawings of such a size that they can always be kept flat.

Filing cabinets, substantially and artistically made, for both vertical and flat filing, are quite generally on the market. It is good economy in furnishing equipment for a drafting room to adjust its requirements, as far as possible, to such "ready-made" articles as may be easily purchased. This makes systematic expansion of the department possible at reasonable cost, providing supplies have been obtained from such well established concerns as make interchangeable styles, and can furnish additional parts as desired. Special cabinets can be made to order but will cost considerably more than corresponding stock goods. Filing cabinets come in what are known as upright and horizontal units or sections. The upright units are about 60 inches high and from 12 inches to 24 inches wide, and so are convenient for frequent reference, but are economical of neither wall nor

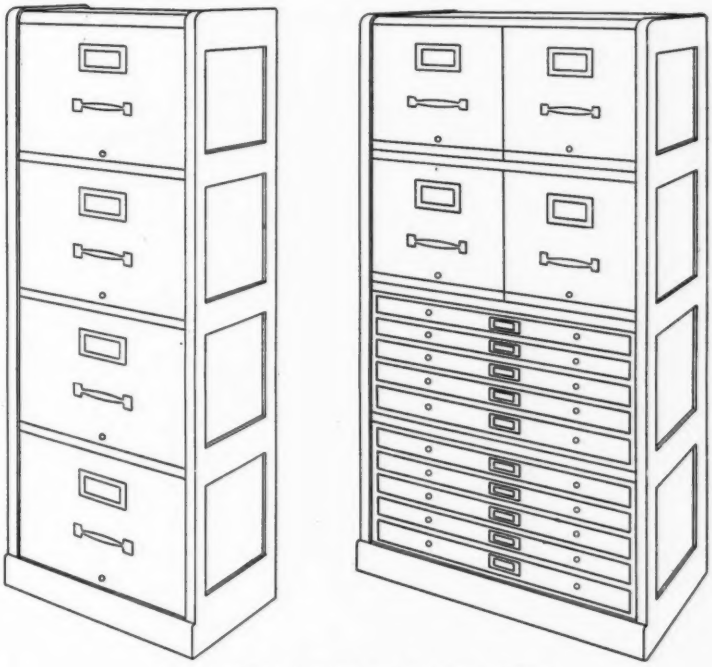


FIG. 5. VERTICAL UNITS FOR FILING CABINETS.
Indicating the possibilities of varied arrangement in each unit.

floor space. Horizontal units come about 36 inches long and 12 inches high. They may be stacked in tall tiers and are better for the storing of papers than for current use. Both styles provide for about 18 inches of filing space, front to rear. Drawers in vertical filing cabinets are made to accommodate approximately the following sizes of folders: 6 inches by 9 inches, 7 inches by 10 inches, 9 inches by 12 inches, and 9 inches by 15 inches. Such styles of vertical files should be chosen as make use of all the available drawer space. (Some styles take considerable room for follower blocks, etc.) The sizes of flat filing drawers have not as yet been reduced to what might be termed standards, but are made in various sizes up to 18 inches by 25 inches. Larger than this must be made to order. It is possible and often desirable to have both vertical and flat drawers in the same cabinet, but this depends upon the needs of the individual drafting room. Office equipment of all descriptions comes to such an extent

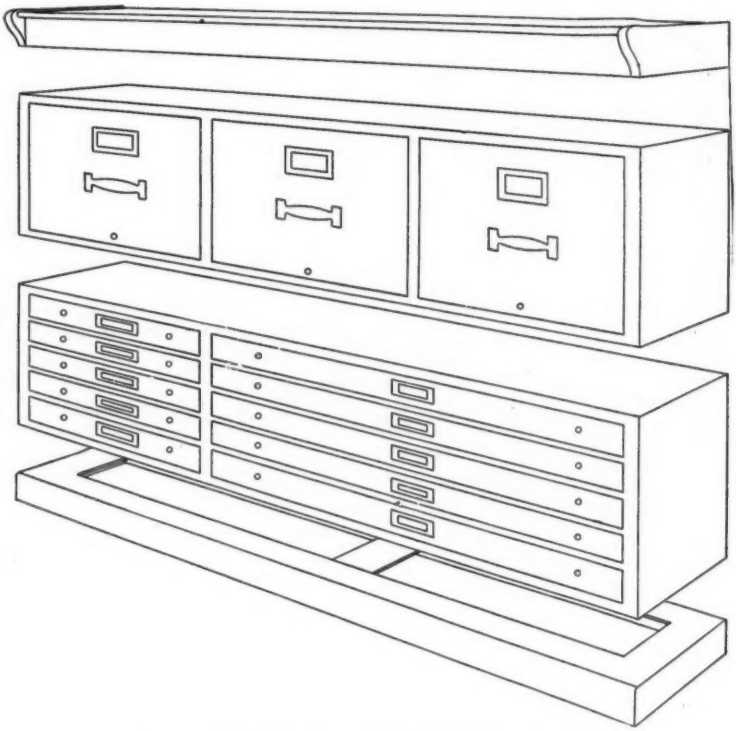


FIG. 6. HORIZONTAL SECTIONS WITH BASE AND TOP.

in interchangeable shapes as to permit almost any desired arrangement or combination.

In the discussion of the making of drawings, the arrangement, size, materials required, method of numbering, system of indexing, mechanical aids, and economy of labor are the chief subjects to be considered.

The custom of crowding together as many detail drawings as possible on one sheet is most unfortunate and unwarranted, and yet it seems to have come into quite general use. Such a custom is expensive and tends to create endless confusion in the filing of drawings in the drafting room, and in the assignment of work in the machine shop. I have often noticed wastefulness caused by this confusion in the following ways:—several machinists going to and fro consulting

the same drawing; a large sheet of details cut up into a variety of irregular shapes and sizes for proper assignment, with the result that plans and parts are often lost; and several draftsmen waiting to refer to different parts of the same sheet of details. Large drawings are always awkward in a shop, as they are inconvenient to use after having been either folded or rolled. The best modern practice is to put one complete detail drawing on a sheet, and let that sheet be of a size consistent with rapidity and accuracy on the part of the draftsman, and suitable for the economical shop production of the work specified. This sheet should contain all the instructions necessary for the completion of the work, and should be legibly numbered for the convenience of all departments. This practice permits the same detail to be used in a number of different machines, without duplication of drawings or other confusion.

The selection of a series of standard sizes for drawings is usually determined to a large extent by the character of the work done and other conditions existent in each drafting room. It is nearly always possible to make the size most frequently used conform to some one of the regular sizes of filing equipment described, and call this the base or unit size. Whenever practicable this should be less than 9 inches by 15 inches, that the greater part of the drawings may be filed vertically, for reasons previously given. Draftsmen should understand thoroughly the advantages of making all drawings of this unit size, in all cases where accuracy and clearness of detail are not sacrificed. Larger drawings usually may be reduced or divided into sections for the purpose of conforming to this unit size. Such uniformity will greatly simplify the filing problem. It will be necessary, however, to have larger drawings, and in the absence of other limiting conditions, the following arbitrary rule for determining a series of standard sizes will be found quite satisfactory; that the larger sizes be multiples of the base or unit size. E. g., a suitable size for small machine details is 8 inches by 10 inches, which is ordinary letter size, and easily accommodated in the 9 inches by 12 inches vertical filing drawers. This size is convenient for both draftsman and machinist. The series of standard sizes with this as a base would be 8 inches by 10 inches, 10 inches by 16 inches, 16 inches by 20 inches, 20 inches by 32 inches, 32 inches by 40 inches, 40 inches by 64 inches, etc. Such a simple multiple series is easily remembered by the draftsmen, and also makes it possible to fold larger prints down to smaller sizes for purposes of transportation. If the base size were 7 inches by 9 inches, the series would be 7 inches by 9 inches, 9

inches by 14 inches, 14 inches by 18 inches, 18 inches by 28 inches, 28 inches by 36 inches, 36 inches by 56 inches, etc., and the first two of these could be filed vertically.

Most drafting rooms are accustomed to purchase their supplies of paper in rolls, and where drawings are of such widely varying sizes as to prevent their reduction to a standard series, this method of purchase may be wise. It is, however, never easy to keep either flat or vertical any papers that have ever been rolled, and for the methods of filing suggested in this article, the purchase of paper in flat sheets is strongly recommended. Many drafting rooms find it to their advantage to use such kinds of paper as may be secured from wholesale paper houses in ream lots rather than to procure their supply from firms dealing in drafting materials. Paper bought flat can be delivered cut to sizes a little larger than standard (allowing for thumb-tack margin, etc.) and, if the multiple series of standards is used, the larger sizes can always be cut down to the smaller without waste. The use of small drawings permits the employment of tracing paper instead of the more expensive tracing cloth, except where tracings are to be subjected to severe wear. Blue prints that are to have hard usage in the shop should be mounted on stiff cardboard; where the mounting is of frequent occurrence it is good economy to have cardboard coated with the sensitive solution, and blue-print directly on that, thus eliminating entirely the operation of mounting.

A standard method of placing name, number, and other needed instructions on drawings is always desirable. For vertically filed drawings the following arrangement will prove convenient: the upper right-hand corner to contain plan number, upper left-hand corner the name of the drawing; both of which may be consulted in a vertical file without removal. In the lower corners may be put the scale, specifications as to material and finish, and a list of such standard screws, nuts, pins, bolts, etc., as belong with the part, if the nature of the work does not require such standard supplies to be put on a separate sheet. When drawings are to be filed flat, the lower edge is the one that can be consulted without removal, and the right and left-hand lower corners should contain respectively the plan number and name, the remaining information being in the upper corners. The time required to properly letter drawings as outlined above is a serious item in many drafting rooms, and the attempts to solve it by impressions from metal or rubber stamps or stencils have proved unsatisfactory. An efficient method is to have a form printed in opaque black ink (by a regular printing office) on standard sizes of tracing

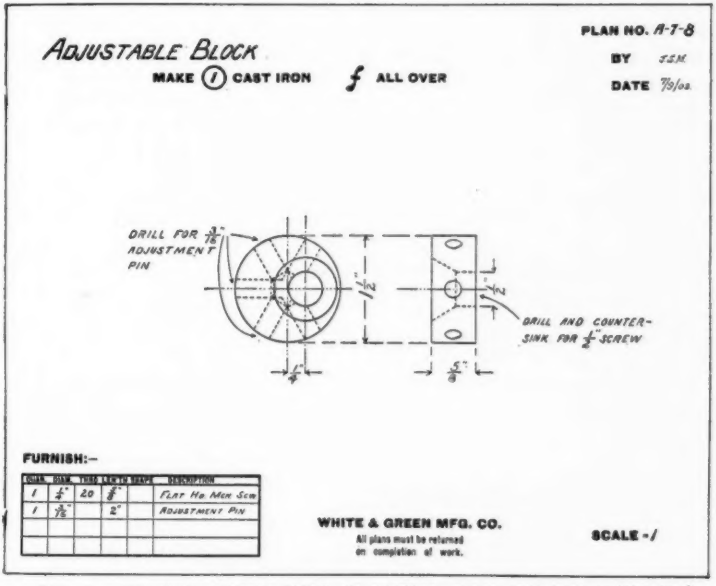

ADJUSTABLE BLOCK
MAKE (1) CAST IRON
f ALL OVER
PLAN NO. A-7-8
BY J.E.M.
DATE 7/10/02
DRILL FOR 7/32" ADJUSTMENT PIN
1 1/2"
1/2"
DRILL AND COUNTER-SINK FOR 1/4" SCREW
1/4"
5/8"
FURNISH:-
NUMB. | NAME | SIZE & DRWG NUMB. | DESCRIPTION
1 | 1/4" | 20 | 3/4" | FLAT HD. MCH. SCR.
1 | 7/32" | | 2" | ADJUSTMENT PIN
WHITE & GREEN MFG. CO.
All plans must be returned on completion of work.
SCALE - 1

FIG. 7. SPECIMEN TRACING MADE ON PRINTED FORM, SHOWING STANDARD METHOD OF MARKING.

Reduced from 8 by 10 inches.

paper or cloth, such form to contain all words or instructions that must go on every drawing, such as " plan no.," " date," " by," " scale," firm name, ruled schedule for the list of standard supplies, and any other standing instructions that may be required. This will save considerable of the draftsman's time, give the drawing a neat and orderly appearance, and make it less easy to forget to insert any of the information for which printed spaces are provided. In smaller departments, and where the printing of such forms is not feasible, similarly lettered dummies of the various standard sizes can be carefully prepared on heavy cardboard, and thus maintain the standard locations of the various items of information, and enable them to be quickly traced.

To be efficient the system of listing or indexing drawings should be so simple that each draftsman can make proper entries of his own work in such a way that it can be easily understood by anyone who may have occasion to refer to it. Libraries have solved a corresponding question for books in the well known Dewey decimal classification system, and a similar method has been found to serve well

DESCRIPTION *PRESS - AUTO - 7"* MACHINE NO. *73.*

PLAN NO.	NAME	DATE	BY	KIND	PLAN NO.	NAME	DATE	BY	KIND	PLAN NO.	NAME	DATE	BY	KIND	PLAN NO.	NAME	DATE	BY	KIND
A-73-1	CRANK	7/06	P	T	26					51					76				
B-73-2	FRAME	7/06	P	S	27					52					77				
A-73-3	STUD	7/06	S	T	28					53					78				
C-73-4	ASSEMBLY	8/06	M	T	29					54					79				
5					30					55					80				
6					31					56					81				
7					32					57					82				
8					33					58					83				
9					34					59					84				
10					35					60					85				
11					36					61					86				
12					37					62					87				
13					38					63					88				
14					39					64					89				
15					40					65					90				
16					41					66					91				
17					42					67					92				
18					43					68					93				
19					44					69					94				
20					45					70					95				
21					46					71					96				
22					47					72					97				
23					48					73					98				
24					49					74					99				
25					50					75					100				

Entries must be made in pencil when drawing is commenced, and in ink when completed.
Standard Sizes: 8"x 10"= A; 10"x 16"= B; 16"x 20"= C; 20"x 32"= D; 32"x 40"= E; 40"x 64"= F; 64"x 80"= G, etc.
T = Tracing; P = Blue Print; S = Sketch.

FIG. 8. CARD-INDEX RECORD OF PLANS. REDUCED FROM 5 BY 8 INCHES.

for drawings in the drafting room. Take for instance: "Plan No. B—41—65" and analyze the three component parts of this number. "65" indicates that the drawing in question was the sixty-fifth on this particular machine or piece of work on hand, and this much of the plan number is assigned as soon as the pencil sketch is started. "41" serves as the distinguishing number of the machine in process of design, or a certain section of it, if it consists of many drawings. It may represent equally well the group number of any other kind of drawing. The letter "B" refers to the size of the drawing in question, and shows in what size filing compartment it may be found. Previous to this a series of standard sizes should have been determined and each size given a letter designation as: A, 8 inches by 10 inches; B, 10 inches by 16 inches, etc. If necessary, more than three component parts of a number may be used.

A complete list should be kept of the different plans on each machine or group, and the form on page 376 will be found serviceable. It should be printed on either 5-inch by 8-inch index cards or loose-leaf-ledger sheets. The foot notes sufficiently explain its use. It is sometimes convenient to keep these lists on printed cards 8 inches by 10 inches and file in the vertical file with the drawings. In large drafting rooms an alphabetical, or otherwise classified, cross index of machine or group numbers is necessary.

The employment of mechanical devices for computation and measurement is to be encouraged wherever accuracy and economy are conserved or increased. The use of the so-called drafting machines is not to be recommended, as they are usually cumbersome, and either too stiff for convenient handling, or too loose to be accurate. Where cross-hatching is to be done in considerable volume, some of the simpler forms of parallel-ruling devices will be of value. But the use of all mechanical aids depends so much upon the nature of the work as to place the responsibility, and properly, upon those immediately in touch with the situation.

The economical use of valuable time should receive careful attention in a drafting room, but the limits of this article will permit only the general statement of the fundamental principle: each and every employee should be given work that will draw out the best of his ability. E. g., it is rarely advisable to assign the routine work of tracing details and lettering to one who is able to do more important work, as such a procedure is at once discouraging to the man, dwarfing his abilities and ambitions, and at the same time not economical from the standpoint of the employer, as it introduces a disproportionate ratio between the cost of labor and the value of the work.

THE HEAVY MOTOR VEHICLE INDUSTRIALLY CONSIDERED.

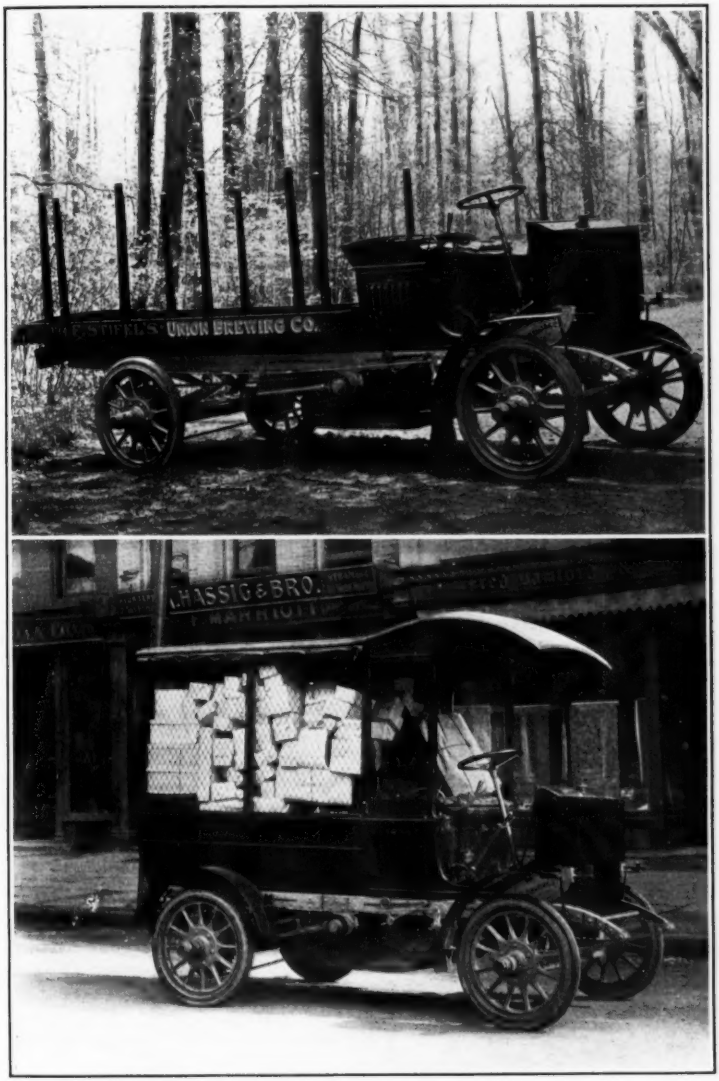
By John McGeorge.

Mr. McGeorge approaches his topic from the American point of view, thereby supplementing and completing the survey formerly made of the subject in these pages by F. M. Maynard, who reviewed British motor vehicles, and more recently by L. Perissé, who in our issue for March, 1905, summarized the state of the art in France up to that time.—THE EDITORS.

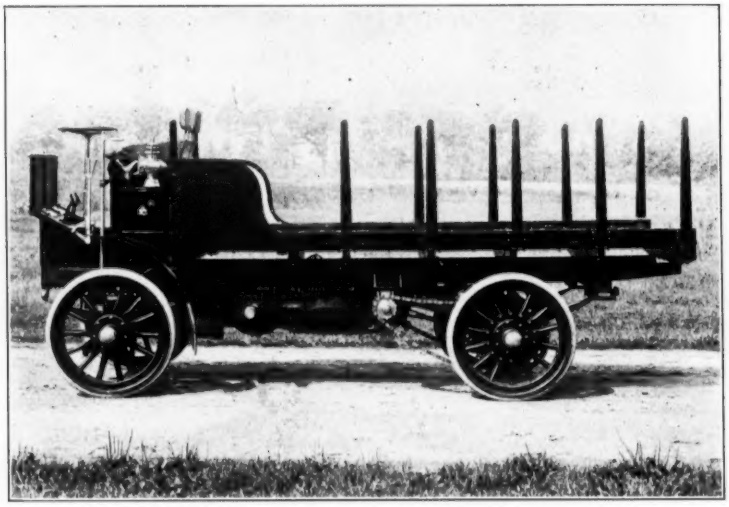
CONSIDERING this subject from the American point of view, we naturally look first at the general conditions under which the vehicles are to operate. Our attention is at once attracted by the inadequate facilities for transport between the city and country for comparatively short hauls, say from 10 to 30 miles into the country, or from large cities to nearby small towns. For instance, a store in a city sells a bill of goods(say household furniture) to a customer 20-miles out; this is too far for delivery by wagons, as it would necessitate a two-days trip, and by rail would cost too much in terminal charges and transferring from dray to railroad car and back to dray; but by motor wagon the whole trip can be made in one day, without any transferance.

The delivery companies which try to deliver from city to country are few and small and can seldom afford more than one or two-horse wagons for this purpose. Hence the need for better service, and this points in the direction of the heavy motor vehicle. There is also involved the question of road surface, type of vehicle, tires, administration, etc., all of which will be considered hereafter.

Considering the particular conditions under which to operate, we first turn to the service. For dry-goods and similar houses, we seem to require light, fast-running vehicles, with a carrying capacity from 1,000 pounds to 2,000 pounds; for the city delivery of light parcels, this field is being filled very acceptably by a number of firms, such as the "Oldsmobile" and others, which have adapted the chasses of their pleasure cars to this purpose. Houses of this character also run heavier vehicles of the same type up to 4,500 pounds, and also, in common with other merchants, require open trucks, such as are made by the Maxwell Company, the Knox, and others, both of the open and closed types.



TWO EXAMPLES OF THE OLDSMOBILE—A HEAVY TRUCK AND A LIGHT DELIVERY WAGON FOR CITY SERVICE.



KNOX WATERLESS 3-TON TRUCK, REMOVABLE STAKE BODY.

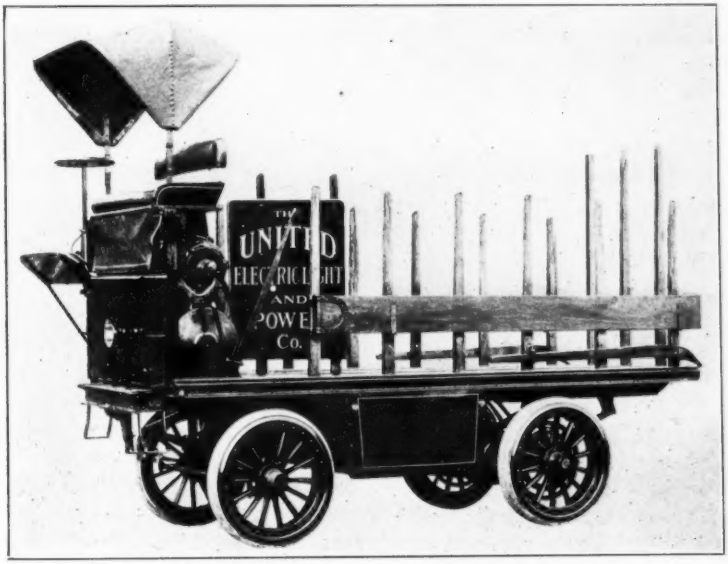
Wheel base 111 by 60 in.; wheels 36-in. diameter; tires 4-in. front and 5-in. rear; body 12 by 5½ ft. inside; weight, 4,800 lbs.; engine, 2-cylinder, 5 by 7, air cooled. Knox Automobile Co., Springfield, Mass.

Hardware and similar houses require principally the heavier type of vehicles, and these firms are so mixed with the supply houses that not only the types shown are used, but also a heavier open type, such as the 5,000-pound to 6,000-pound Knox. Warehouses and express companies call for open lurries, with flat tops or stake sides, of the type shown by the Holson Company, and the Packard Company, of all capacities from 2,000 to 10,000 pounds. Structural-iron workers call for lurries with perfectly flat tops, with the exception of the driver's seat, of capacities from 1,000 to 10,000 pounds and over, of types which have not yet been seen in America, but which are growing common in Europe.

The next point in the consideration of conditions is that of administration; by this we mean principally the personnel of the men in charge of the installation. Large stores with their own stables, etc., usually put a competent man in charge who knows how to keep his horses and plant generally in good order, and also does not hesitate to tell the general manager just how much his department can do. Similarly we require a man in charge of an auto delivery plant, whether it be one vehicle or a hundred, who knows what should be

done to keep his vehicles always in order, and *who will do it.* The superintendent of the delivery service also should study the powers of the motor wagon, as to speed, length of routes, frequence of stops, etc., in order to suit his service; in the horse delivery service, this suiting of service has gradually grown up and crystallized into a set route at set times, but the motor wagon is often put in as a complete installation, and requires the whole system to be devised at once; and as the motor wagon will make from 30 to 50 miles per day, or more than two trips to the horse-wagon's one, this will call for more careful adjustment of hours for preparing and loading shipments, and will keep the packers and shippers more steadily at work.

The economy of auto delivery is now at such a point that the balance is on the side of the auto vehicle; but given two exactly similar plants, one man will show a good margin of profit on the side of the auto, whilst another man will show a big margin on the other side. Montgomery, Ward & Company say: "The maintenance means a great deal, and unless it is carefully looked after by one who thoroughly understands it, the trucks will lose money very quickly."



FIVE-TON ELECTRIC TRUCK. RADIUS OF 25 MILES ON ONE CHARGE.

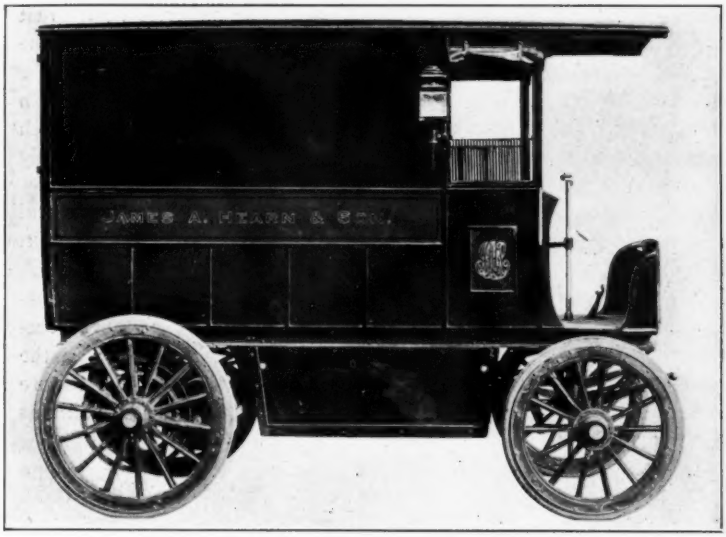
Note electric and hand-power winches and skids for loading. Built especially for cable reels, etc. Speed 6 miles per hour. Vehicle Equipment Co.

This does not necessarily mean that an expensive man shall be put in charge, but that a man should be picked out who will love his machines, just as a good man will love his horses.

Next we have in the conditions to be considered the question of road surface and foundation. We have to confess to all kinds of roads in the United States. Our dirt roads (?) are simply a heap of soil scraped up into a ridge by the farmer's scrapers; these wear into ruts with a big ridge between, and this is often forgotten in allowing for the road clearance. These roads are also soft, needing broad tires; this also is frequently forgotten or wilfully ignored. They also wear in holes, and these holes fill with water which splashes up and carries mud and dirt into unprotected parts. Macadam or telford roads are liable to all the foregoing faults, but in a much less degree, depending upon the quality of the foundation, but with the further fault that when there is a hole, the wheels drop in with a greater shock. Asphalt roads have all the faults of macadam roads, of course in a still less degree, with the added fault of slipping and skidding in bad weather. Stone pavements have the fault of jarring the machinery, and so have wood pavements in a lesser degree. This looks like a formidable indictment of the roads, but we are at present looking for faults in order to provide remedies on the vehicles. All these conditions affect the questions of tires, power required, ease of steering, whether the load should be hauled or pushed (front or rear drive), or carried or driven by all four wheels.

Another condition which must be considered is that of the width of streets in some cities and the closeness of the space for manœuvering. Again, we have the question of grade to look at. At Tarrytown, N. Y., grades generally may run up to 16 per cent; at Cleveland, O., we have grades up to 12 per cent, and at Cincinnati, O., about similar grades, so that we should provide power in most places for at least 20-per-cent grades on the slowest speeds, in order to allow for bad spots and holes.

Having looked at the general conditions of the road service, etc., we are now ready to look at the types of machines. First, steam comes naturally to our thoughts; steam has had a great run especially for heavy loads on account of its flexibility. If the engine is made large enough to pull the vehicle out of any hole it may get into, then the speed can be adjusted to any point by means of the throttle, and this has been the strong point in favor of the steam engine. A steam engine will run and get home even if badly out of repair, and it seldom happens that a boiler gives out all at once. Against these points,



A LIGHT DELIVERY WAGON OF 30-MILES RADIUS AND 10-MILES SPEED. CARRYING CAPACITY 1,000–1,500 LBS.

The Vehicle Equipment Co., N. Y.

is the fact that a steam engine takes more fuel in the shape of gasoline than an internally fired engine, and that the machinery is heavier than a gasoline engine, thus reducing the load efficiency in proportion to total weight.

A flash or semi-flash boiler will keep in good repair for a long time, but the burner and its regulator need close watching, and the water regulator must also be closely adjusted. A tubular boiler soon gives trouble, by burning out tubes, and even the most expert chauffeur gets caught occasionally. A condenser must be carried or water must be taken at frequent intervals. In all this I have only considered a liquid-fuel furnace, as I believe that none would seriously think of a coal or coke-fired boiler.

The transmission of a steam engine is simple, as we only have enough gearing to allow the engine to run at a fair speed in order to keep down the size of the cylinders.

In electric vehicles we have an ideal transmission of power, in that we can obtain a large range of speeds with little loss of efficiency. We also have a very simple mechanism with regard to motor and transmission. We have an ideal vehicle in regard to quietness and

cleanliness, but here the advantages end. The batteries need great care; they are costly and deteriorate quickly, and are heavy. The cost of operation per road mile is great, amounting to 1 cent per ton mile of freight in the very best case we have record of; and in this case the load being 4 tons, the vehicle also weighed 4 tons, which equals ½ cent per ton mile of total load. This cost is for fuel only (current).

Gasoline engines have rapidly come to the front in late years and are now very reliable machines. The advantages are low fuel cost, light weight of machinery, and considerable flexibility of control. The disadvantages are increased cost and complication in the transmission gearing, the use of electric spark with its consequent batteries or magneto, and the carrying of gasoline (and water in the case of water-cooled cylinders) and the demand for a somewhat more experienced driver of the vehicle. The control is not as flexible as that of steam, but more flexible than electric.

ELECTRIC TRUCK WITH MOTORS IN THE WHEELS.

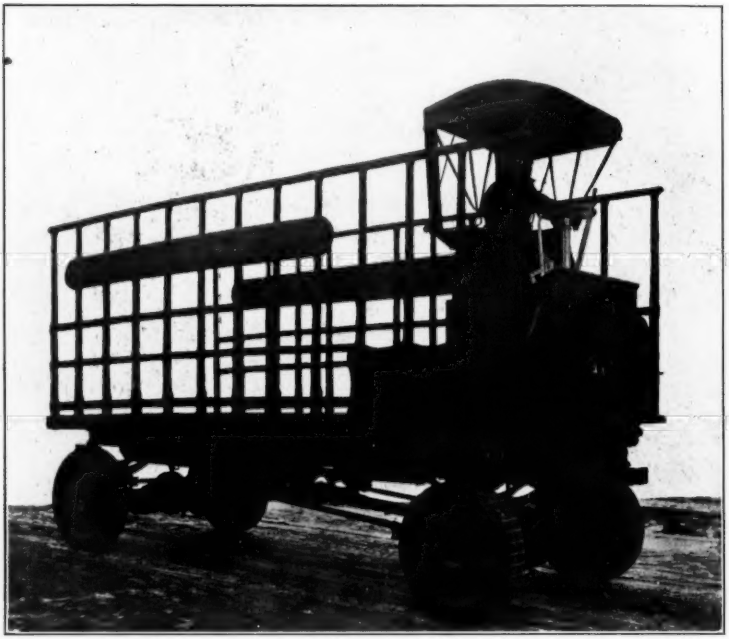
Four-tons capacity, steering on four or two wheels; or, front and rear wheels can be set parallel to travel obliquely. Holson Motor Patents Co.

A MAXWELL TRUCK MAKING AN AVERAGE OF 17½ MILES A DAY WITH 2,200-POUNDS LOAD.

10½ miles per gallon of gasoline, maximum grade 16 per cent; two cylinders, 5 by 5; wheels, 32-in. diameter; tires, 3½-in. front and 4-in. rear; platform, 10½ by 6 ft.; weight, 2,600 lb.

Crude-oil engines have not yet been proved to be sufficiently successful to warrant their general employment, although we have records of gasoline, heavy oil, pure alcohol, and carbureted alcohol being used in the same engine without alteration, with good results.

Combination power plants have come rapidly to the front, notably in the gasoline and electric combination, the most successful of which has been a gasoline engine driving an electric generator with a storage battery to take the surplus, the power being applied by means of electric motors to the axles. A large railroad car built on this system is now running over the various roads of the United States, with remarkable success as to smoothness of running, cost of fuel, and cost of repairs. Whilst speaking of railroad cars I may say that a car is now having its machinery put in it at Akron by the Wellman-Seaver-Morgan Company, with gasoline engines geared to the axles. This engine has eight cylinders, 8-inch diameter by 8-inch stroke, and is estimated to give 200 horse power at a speed of about 750 revolutions. There are three speeds, each operated by a separate clutch. The cars are 45 feet long over all, and seat 44 passengers. It is intended to



SEVEN-TON GASOLINE TRUCK, EACH WHEEL INDEPENDENTLY DRIVEN, STEERED AND BRAKED.

Wheels, wood-tread, 8-in. wide; engine four-cylinder, 6 by 6, water-cooled; drives through bevel gears; speed 15 miles; body 18 by 7 ft.; a windlass can be operated by the engine, independently of the wheels, for loading or for getting out of a hole.
The Four-Wheel Drive Co., Milwaukee, Wis.

make an average of about 35 miles per hour, with a maximum speed of 60. The control is by throttle in addition to the changes of gearing. The electric lights for the car are supplied from a storage battery which also gives power for the air compressor, the brakes, and to start the main engine. This car is being built for use on the L. S. & M. S. R. R., under Mr. Chase's patents.

The third of the conditions is one closely related to the question of roads, viz., tires. For commercial work we have on the market, first, solid-rubber tires, many of which have been very successful, but we have to face the fact that rubber is becoming more scarce and expensive every day. Some firms are turning to wood blocks in the tires, as in the truck made by the Four Wheel Drive Wagon Company, of Milwaukee, Wis., who are using these blocks,

with the end grain turned to the roadway, and with good sucess. It is still a question if we will not be able to return to the use of steel tires of sufficient width not to injure the roadway. It is possible that some modification of the various spring tires which have been suggested may be found to give the necessary grip, without cross bars. Pneumatic tires can be used only up to comparatively light weights and are practically out of consideration for commercial work.

Having gone over the conditions under which we are to operate, let us look at some of the machinery.

In the steam machines, among the most practical seem to be the White cars, with their semi-flash boilers. In these boilers, the water is pumped in proportion to the speed of the engine, with the result that when the engine is laboring, in consequence of a heavy road or grade, and is running slow, the pump is also running slow and failing to give steam to the engine. This has been partly remedied on the " 1906 " cars by giving a change of gearing for the heavy work, so that the great advantage that steam had in its flexibility of control, as compared with gasoline, really disappears when this point is considered, together with the smaller efficiency of the fuel in its conversion to power through the medium of the furnace boiler and engine, its less weight efficiency (that is greater proportion of dead weight to paying load) it would appear that the field for steam vehicles is rapidly diminishing. The strong point influencing the selection of steam for any given service is that almost any mechanic can repair and adjust a steam engine and its attendant machinery.

Electric vehicles have a field which seems to be peculiarly their own in the light delivery service, from dry-goods houses and similar work, especially when the service is sufficiently large to warrant the establishment of a good sized garage with an efficient superintendent; but these vehicles should not be used when the grades are heavy, as the storage battery is best suited for a steady delivery of power at a comparatively low rate. The expense of running these vehicles amounts to approximately 2 cents per ton mile for current. The brewery-wagon field seems to have been practically pre-empted by the electric vehicle, but why I cannot see, except that where a garage is maintained with an efficient staff, a cheaper class of driver can be used; but we find that some of the large companies are now trying gasoline vehicles for this service, with good results. The expense of tires is greater than either steam or gasoline as the dead load is greater, and the upkeep of the batteries is another heavy item.

The gasoline vehicle has been so much improved in all its details

that it would seem to fill the bill for all classes of work. The engine has been improved in its flexibility by the addition of more cylinders (although this is against it on the score of multiplication of parts) and the recent advances in air cooling would seem to indicate that it is possible to dispense with the water tank. It is necessary to have a little higher grade of intelligence on the part of the driver to detect and remedy any faults which may show up in the carburetor or the spark connections (which, by the way, are invariably the result of careless work in the fitting of the wires and connections), and the various adjustments required. Here again the necessity of a good man in charge of the installation shows up, as the difference in management will make all the difference between success and non-success.

A THREE-TON TRUCK WITH BODY FOR WHOLESALE GROCER'S SERVICE.

Note underframe with engine geared by spurs to axle; two cylinders, 6 by 7; wheel base 9½ ft. by 58 in; wheels 36-in. diameter; tires, front 5-in., rear 6-in.; weight, 6,000 lb., speed, 10 miles. Knox Motor Truck Co.

Taking the question of economy, we do not find that much has been published showing the cost of operating either steam or electric vehicles.

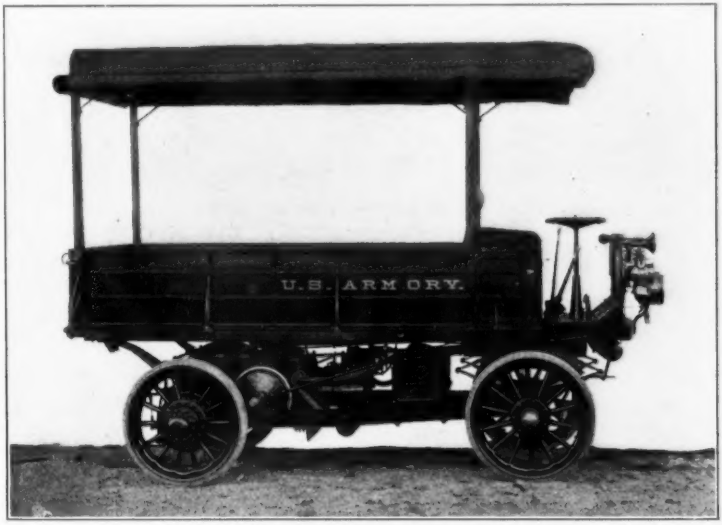
A Thornycroft steam wagon has run at a cost of 7 cents per ton mile in 1902, including all costs.

A Leyland wagon was tested against horse power under the same circumstances, and showed a cost of 12.5 cents per ton mile against a cost of 20 cents for horse wagon; this was in 1899.

In 1898, a three-ton Thornycroft wagon carried its load at a cost of 0.7 of a cent for fuel per ton mile.

A three-ton Leyland wagon carried its load at a cost of 1.1 cent for fuel per ton mile. It is not probable that the cost of running has been reduced since that time, and it is more than probable that the American vehicles can run about the same in cost of operation.

The Holson electric truck, which drives all four wheels with a separate motor in each wheel, claims an economy of 200 watts per ton mile, which at 5 cents per kilowatt would equal a cost of 1 cent per ton mile for current. An ordinary electric vehicle will probably cost at least 2 cents per ton mile for heavy vehicles and much more for the lighter cars. The cost of batteries must also be charged to the fuel account, and it is impossible to say just what this will be as here, particularly, the personal element of the superintendent comes in.



A TWO-TON TRUCK WITH EXPRESS BODY AND TOP.

Engine, two-cylinder, 6 by 7; wheel base, 8 ft. by 5 ft. 8 in.; wheels, 36-in., tires, front 4-in., rear 5-in.; weight, 4,000 lb.; speed, 12 miles. Knox Motor-Truck Co.

Repairs are also a very indefinite quantity. One firm in Cleveland, Ohio, gave up a delivery wagon on account of the cost of repairs, which in my opinion was solely on account of the incompetence both of the man in charge and the repair man. Gasoline vehicles have the cleanest records of all, I have before me a record of a Knox, gross weight approximating 2 tons, in the Glidden Tour, including all stops,

etc., in a 1,000-mile run, at a cost of $23.50; this equals 2.35 cents per mile for gasoline and lubricating oil. The load carried varied from 1,500 to 2,500 pounds, and a great deal of hill work was done. The gasoline cast 20 cents; in Cleveland we pay 11 cents; this would bring the cost down to 1.4 cents per mile. The Packard Company, on the same tour, with a net load of 1,500 to 3,200 pounds, consumed 39 gallons of gasoline at 11 cents (the price in this city) = $9.79, plus 4 gallons lubricating oil = $2.00; total $11.79, or 1.17 cents per mile. These are not exceptional records, but taken from the first we have at hand.

The question of repairs is again a very variable one, but with well made cars of the quality of material now being used by the best makers, and a good man in charge, they should be a very small item. Amongst the conditions that are common to all the classes of vehicles, is the question of road clearance. As mentioned in the beginning of this article, it is essential that the vehicles be suitable for traveling over poor roads full of ruts and holes. I note that in London, with its good roads, the minimum clearance specified by the authorities for motor 'buses is 10 inches, and I think that for American roads this should be at least 12 inches; this would call for somewhat larger wheels than American makers have been using, but this would be a good thing all around.

The width of tires has also been touched upon, and here it is to be feared that Americans are not wise. On horse vehicles we have used narrow-tired buggy wheels, because for the one particular trip we run lighter, forgetting that the light running is at the cost of cutting up the road and making it so much the worse for the man following us. This tendency also obtains in our motor vehicles. If we used broader tires we would soon find that the results would pay in the improved condition of the roads, and this, of course, would react on the power required. We should therefore insist that one of the most vital conditions of success with any type of commercial vehicle is that the tires shall be broad enough to carry the weight without cutting the roads. If manufacturers could get together and determine the width of tire for a given load, making this load suitable for soft-dirt roads, we would effect a long step forward. The material of the tires affects the mechanism. We have an instance of a back axle with roller bearings which was standing its work perfectly with pneumatic tires, but a customer wanted solid tires and in one week's run the axle was reduced 1-16-inch in diameter, so that in this case the axle should be harder to stand the impact

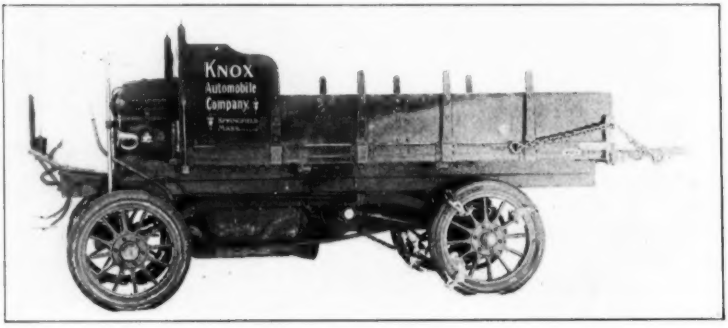
AN ELECTRIC VEHICLE OF INTERESTING TYPE.

from the road surface through the solid tire. Under the speeds called for by commercial vehicles, it would appear that solid tires can be used, either of wood or rubber, and in the case of the heavier, slower vehicles, even steel tires could be used. It is understood that this would call for pinning or otherwise securing all nuts and fastenings, and making all parts both hard and tough; but with the quality of material now being used on this work, this result can be obtained. One essential condition of success is that the transmission of the power from the motor to the wheels shall be as simple and direct as possible.

The question of speeds in the gasoline car is best solved by change gearing, but if this gearing is made of substantial construction, this should never be heard from so long as the car will stand up. The question of compensation between the two sides of the vehicle has been accepted as being solved by the differential, but there is a serious question mark against this. When one wheel of a differential axle strikes a soft spot, the power will simply spin it around, using the other wheel as a fulcrum. Again, with a back-wheel-driven machine, if one driven wheel strikes an obstruction with the other driven

wheel on firm ground, and the forward wheels are at the same time on slippery ground, the result is a skid, and the vehicle will turn back-end first. Now, if the wheels were driven through ratchets (as is practically done in the Hedgeland patent) the result would be that the wheel against the obstruction is the one that would have the power applied, and in the case of a soft spot, it would be the wheel on the firm ground that would have the power applied to it. Here is food for thought, for in my opinion the differential is not the best solution. The "Holson" and the Four Wheel Drive Company solve this by putting power separately into all four wheels.

Again the question arises, which wheels should do the driving, the front or the back wheels? I think all are agreed that the front steer is the best, and it would appear to be easier and more efficient to pull the load than to push it. This would imply that the power and the steering should be applied through the front wheels, and that (better still) all four wheels should be driven; the motion then



KNOX WATERLESS 2,500-POUND TRUCK, STAKE BODY WITH PLANK SIDES.
Note the chain grips on the drivers.

becomes one of translation only and eases all the strains of driving from the body of the truck. Whilst on the subject it would appear that for bad-road work for heavy trucks, we should take a leaf out of the English traction-engine books and use a small windlass on the trucks which can be used to pull out of a bad hole; this windlass can also be used for loading the trucks.

Considering the purpose of this article, which was to try to determine where each type of machine should be used, it would appear that the field of the steam engine is rapidly narrowing, as its one great advantage—that of its flexibility of control—is being caught up

A 7,000-POUND LOAD OF COKE ON AN "ATLAS" TRUCK.

Two-cylinder engine, 6 by 7; wheel base, 9 ft. 6 in.; tread, 58 in.; wheel diameter, 36 in.; tires, rear 6 in., front 5 in.; weight, 6,000 lb.; speed, 10 miles an hour.

with by the gasoline motor. Its next advantage, that of increasing pressure for hill work, is more than discounted by the ease of changing gears of the gasoline, and we have seen that both steam and electric have had to copy the gasoline in this particular. But where established mechanics, who are not familiar with electric and gas engines, have to take charge, then the steam has its field.

The electric power seems to have its advantage for short hauls, for goods that would be affected by gas fumes or damp, or where quietness is an essential, or where a natural source of power (such as a waterfall) is available. But nearly all the advantages inuring to the steam and electric systems for commercial work are closely approached by the gasoline, or internally fired engine. By the multiplication of cylinders and the improvements in the carburetors and throttle and other systems of control, we are now making the control of the speed in these engines very flexible. By good systems of transmission, especially by sliding gears, in view of the excellent quality of material now being used, and other systems which are now under experiment, a power of climbing hills and getting out of holes is possessed by the gasoline engine which surpasses either steam or electric. The one drawback is the apparent complication of the engine, and the want of knowledge of the gasoline engine, especially of the electrical parts necessary, both on the part of the manufacturers

and users of this machinery. I say manufacturers advisedly, for repeated instances have come to my notice, of either careless or ignorant wiring, and even in induction coils I have seen careless workmanship which gave considerable trouble before the cause (which was slight and easily remedied) was found out. But this fault should be overcome by the employment of competent men in the case of large installations, and in the case of one or two wagons the owner himself must be familiar with his plant.

With respect to fuel economy, the internally fired engine is pre-eminent, as shown not only by demonstration, but by figures from months of running which have been published by both manufacturers and users. And in the economy of repairs, the internally fired motor is coming to the front, as manufacturers are realizing the conditions and providing for them.

Tires I have not gone into closely as these are common to all types. Suffice it to say that as improvements are made in the machinery and springs, the problem of tires will become easier, and harder tires can be used.

Regarding costs, etc., I give some general figures, which, of course, vary considerably, but which go to substantiate all that has been said.

The Moxie Nerve Food Company, of Boston, have run fourteen autos of a light class for two years, and in 1904 the repair bill for 8,000 miles (not including tires) was a little over $5.00. A clothing store at Albany, running a car of the light "Oldsmobile" type says that the car covers about 50 miles per day, equaling the work of two horses and costing considerably less than the keep of two horses.

The Troy Laundry Company of Los Angeles cover about 35 miles per day with each of two small electric cars. Another firm in the same city have covered 50 miles a day with an electric car, and are about to put in six gasoline cars.

Montgomery, Ward & Company are running 5-ton trucks, and wear out a set of tires (7 by 86 inches) in a year, costing $640.00; batteries cost from $600 to $900, and also last one year in hard service. This firm say that motor wagons are undoubtedly cheaper and more efficient in every way than horse wagons and they are doing all their trucking by motor wagon.

The Anheuser-Busch Brewery Company have over thirty electric trucks in St. Louis, and more in other cities and are building more; they are trying out gasoline cars.

Lyon & Healy have gasoline trucks and give the following figures for maintenance and operating:

Gasoline Truck		*Horse Truck*	
Gasoline	$30.00	Horses	$120.00
Oil	6.00	Repairs, Washing, Harness	40.00
Batteries	3.00		
Repairs	2.00		
Driver	180.00	Driver	180.00
	$221.00		$340.00

They also state that one gasoline truck will do the work of two horse trucks. A. H. Revell & Company also state that one motor truck will do the work of two horse trucks, and give the following figures:

Electric Truck		*Horse Truck*	
Driver	$64.00	Driver	$64.00
Charging	30.00	Horse feed	40.00
Washing, Repairs	10.00	Repairs, Harness, Washing	10.00
	$114.00		$114.00
			2
	$114.00		$228.00

H. Bosch Company, Chicago, give the following figures for a light wagon:

Feed for one year	$120.00	Driver for 1 year	$780.00
Driver " " "	624.00	Interest (on 2500)	125.00
Repairs	25.00	Supplies: Gasoline, oil, etc.)	200.00
Shoes for team	35.00	Depreciation	250.00
Interest for one year	30.00	Tires (new set)	132.00
Depreciation (on $350)	130.00	Other repairs	25.00
	$964.00		$1512.00
	2		
	$1928.00		$1512.00

The Frank Parmelee Transfer Company give figures for a gasoline truck for a month in hard service:

Total miles traveled	1,546.5
Averaged speed miles per hour	9.72
Amount gasoline consumed—gallons	179.58
Amount oil consumed—pints	16.875
Number of stops made	2,023.
Average miles per gallon of gasoline	8.45
Average weight of daily loads	6,733.
Average number of stops per day	67.50
Total elapsed time ... hours	342.5
Time occupied in stops "	185.
Net running time .... "	159.
Total cost of gasoline and oil—$	19.33
Daily cost of gasoline and oil—cts	64.1

The Packard Company give the following figures from two companies:

	National White Lead Co. 5 days trial	Standard Oil Co. 3 days trial
No. of trips	13	10
Total miles	190.99	73.75
Average miles per trip	14.69	7.38
Total time	hrs. 28 48 min.	hrs. 11 45 min.
Total running time	hrs. 17 12 min.	hrs. 9 55 min.
Total time for stops	hrs. 11 36 min.	hrs. 1 50 min.
Average miles per hr.	11.1	7.5

The service conditions and economy of performance in the cases of the Packard cars, employed by the two companies whose figures were last cited, are further tabulated as follows:

	National White Lead Co.	Standard Oil Co.
Character of load—	White lead & paint,	Oil in bbls.
Maximum load	4,600 lb.	4,657 lb.
Minimum load	1,600 lb.	400 lb.
Average load	3,999 lb.	3,707 lb.
Gasoline used	22.5 gals.	7.25 gals.
Lubricating oil	2. pints	.333 pts.
Per gal. gasoline	8.49 miles	10.17 miles
Gasoline per mile	.94 pints	.77 pints
Gasoline per ton mile	.48 "	.40 "
Cost of gasoline and oil	$2.38	$0.81
Gasoline & oil per ton mile	$0.0062	$0.0055

Some of the figures given have come directly from the manufacturers and owners; others have been taken from the technical journals; and many others could be given, but enough has been said to show that the pioneer time for motor wagons is over, and it is now only a question of careful engineering, as in any other machine, to make a paying investment of motor wagons.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker.

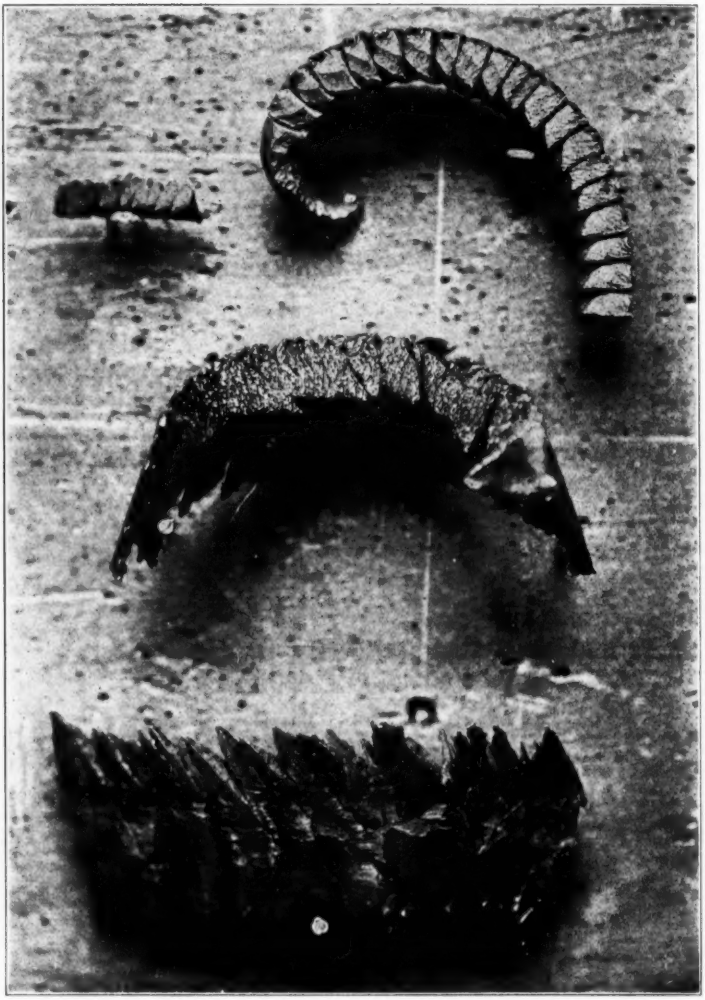
VI. THE TOOL AT WORK.

Mr. Becker's discussion of this subject began in The Engineering Magazine for September, 1905, and extended in that series to a group of four articles, taking up successively the general outline of the problem, controlling principles in introducing the steel into the shop, working directions for the making of the tools, and the design and operation of tools and machines. In this supplementary series he began last month with a discussion of the range of adaptability of alloy-steel tools, and the concluding article will present valuable data of "Feeds and Speeds with the New Tool Steels."—THE EDITORS.

ORDINARILY the thing considered most important, in bringing together a tool and a piece of work, is the mutual adaptation of tool and machine to the work to be done. Another consideration, fully as important, and in many cases more so, is the relation of the tool to the piece to be tooled—the proper bringing together of the work and that which does the work. The form or type of the machine by which this relation is established of course is determined largely by the form of the tool and the nature of the work. Thus, for instance, a rotating tool cutting at its periphery will be used in some one of the several types of milling machines; and in case it is convenient to rotate the piece to be machined, some form of lathe is indicated.

To secure the performance of the work in the most expeditious and convenient manner is the primary end, apparently, of modern machine design. To satisfy these ends the tendency has been to multiply movements and adjustments in the tool-holding and applying mechanism, with a result frequently undesirable, to say the least. The necessity for the greatest practicable rigidity in machine and tool is pretty generally recognized, and it needs no argument to show the advantage of applying the tool to the work with as few intervening parts and at as short a distance from the frame or bed of the machine as may be. Fortunately, in the manufacturing shop at any rate, the use of jigs and rigs makes any great variety of adjustments not only unnecessary, but undesirable; and it is therefore possible to attach the tool to the frame of the machine with little intermediation of parts.

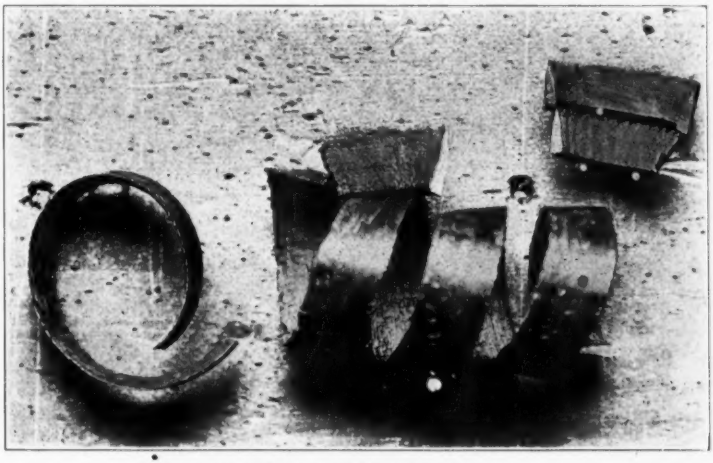
The tool-holding device of whatsoever kind is vitally important, not only to the proper performance of the work, but to the life of



EXAMPLES OF CHIPS MADE BY A HIGH-SPEED PLANER.

The specimen above, cut at a speed of 40 ft. a minute, the chip being $\frac{1}{2}$ by $\frac{1}{4}$ in., shows regular but very slight vibration. The under side is very smooth, showing a clean cut. In the large chip below, $\frac{3}{8}$ by 1 in., vibration is very pronounced and irregular. Note the back of the chip.

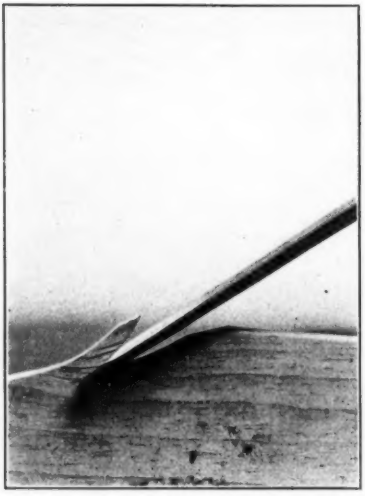
the tool as well. At the very best the tool and holder together are in the nature of a spring acting under tension when at work. It is commonly inferred that if no chattering is heard or felt there is no vibration present. As a matter of fact vibration is rarely, if ever, absent, even in such tools as drills, reamers, and millers. A careful study of the structure of steel chips shows at once the nature and extent of the quivering. In general it is found that the more rigid the combination of machine, tool, and holder, the fewer and less pronounced the serrations and cleavages apparent in the chip. If also the tool is sharp and has considerable rake, these markings, caused chiefly by the quivering of the tool, are still less evident, though not wholly absent.



AN EXAMPLE OF SMOOTH CUTTING.

Vibration is practically absent. The back of the chip, however, shows the work to have been done by a dull tool with little rake, "pushing" the metal off rather than cutting it.

The importance, with respect to the finished work, of reducing this quivering to its lowest terms is obvious. It is no less important to the tool itself; for this it is that destroys the cutting edge of the tool and makes it necessary to re-grind more or less frequently according as conditions approach the ideal. Under true ideal conditions the tool would practically sharpen itself while cutting, and its life be greatly prolonged. As the prolongation of the life of the tool is one of the chief reasons for the use of high-speed steel as a tool material, it is desirable to set the tool at work under the conditions most favorable to the accomplishment of that object.



AN EXHIBITION OF THE ACTION OF A CUTTING TOOL IN WOOD.

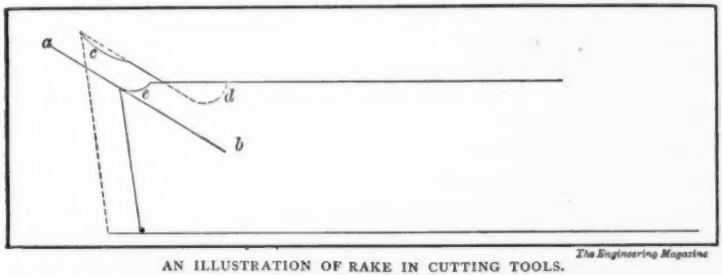
Unless the grain prevents, the line of cleavage tends toward the surface in front of the tool, and the cutting edge is continually lifting new fibres as it advances, and establishing new lines of cleavage.

A finishing tool works with either a splitting or a shearing action (or more often a combination of the two) at right angles with the finished surface. The scraping action frequently seen is only a modified shearing action. The splitting action is readily seen in the case of wood and other materials of a fibrous nature. The edge of the tool lifts the fibres, opening a crack which precedes the cutting edge at a greater or less distance according as the tool is blunt or acute and the chip brittle or tenacious. In so-called cutting of metals, the conditions are very similar, though of course they are much less noticeable because of the less fibrous and more granular structure of metals. The cutting edge of the tool enters the mass of metal and acts somewhat like a wedge, the point of cleavage being in advance of the point of the tool. But as the line of cleavage is bound to be more or less irregular, and in the case of cylindrical work or cutter its direction is constantly changing, the cutting edge must lift up and split off in the same way the smaller particles forming the rough surface under the lifted chip.* If the tool has at the same time a lateral motion, as where the cutting edge is somewhat inclined to the plane of the cut, like that of a spiral milling cutter, there is a sort of scraping or shearing action also, leaving a relatively smooth surface. This is also the reason, it may be mentioned incidentally, why steel may be machined at a greater speed than cast iron and similar brittle materials. In the case of the latter, the chip is so brittle and there is so little fibre that

* It may be mentioned that there is no essential difference between the chip cut by a high-speed tool and that produced by ordinary ones. Such differences as are apparent are for the most part superficial and due to the higher speed at which the chip is curled, rather than to the manner of separating it from the piece being finished. The interest attaching to this circumstance is chiefly that it refutes the earlier impressions gained on the first introduction of high-speed steels. With the earlier tools only rough work was attempted, generally with tools so shaped that the metal was pushed off rather than cut, as the term is generally understood in metal working. Under those circumstances, of course, chips behaved somewhat differently, and there was some justification for the belief that high-speed tools worked with an action different from that of carbon and self-hardening steel ones.

the point of cleavage is only very slightly in advance of the tool point, and is tending constantly toward the surface of the chip instead of moving in the direction of the cut. In consequence the edge of the tool has much more work to do than when cutting steel, in which case most of the work falls upon that part of the tool just behind the cutting edge, where the tenacious chip rubs against the well supported rake surface, and where, in consequence of the constant abrasion, the tendency is to wear a depression or pit and therefore continuously to renew the cutting edge.

Now the pit mentioned is nearly always present on tools (working on steel and similar materials) having little or no rake; but when there is a considerable slant to the surface along which the chip slides off, it is not usually noticeable. Furthermore the angle which the front surface of the pit holds, to the direction of the cut, is tolerably uniform for the same material and conditions of work. The obvious inference would be that the natural angle thus established should be used always, in order to secure greatest efficiency. There are however other considerations; and one of the most important is that already mentioned—the vibration or quivering attending most, if not all, cutting operations.



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AN ILLUSTRATION OF RAKE IN CUTTING TOOLS.

The line a b indicates the slant or rake which in this particular case would allow the tool to work at its highest efficiency, for it is the slant established by the abrasive action of the chip itself. The dotted outline indicates the proper outline for the tool required in this case. Notice the difference in the pits c and e behind the cutting edges. These are, of course, exaggerated in the figure.

If these vibrations took place in the same direction as that of the cut, there would be small harm; but from the nature of the tool-holding arrangement it is never exactly so, being more nearly in the form of the arc of a circle; and furthermore, the stress of the work tends to push the tool away from the work, so that by far the greater amount of quivering is about at right angles with the direction of the cut. The cutting edge of the tool is therefore receiving a constant succession of blows from the under side of the lifted chip, which tend

to break it over very much as is the case when scraping a piece of wood with a freshly broken piece of glass. For this reason it is necessary frequently, perhaps generally, especially when the tool is used on a machine somewhat worn, or not well designed for high duty, to sacrifice efficiency in cutting by using a tool with little rake, in order to secure backing enough to prevent this crumbling of the cutting edge.

The natural thing to do, apparently, is to stop the vibration and thus permit the tool to work at its greatest efficiency. But for reasons already pointed out this is generally impossible without the installation of new equipment designed with reference to this particular end. Expedients for the mitigation of the evil are for the most part of little avail. That of giving the tool just enough clearance to allow it to ride upon the finished surface is frequently of advantage, particularly in the case of lathe work when the point of the tool may be set a trifle above the center line. Another expedient that is often helpful is to increase the feed, or better still the depth of the cut. In light cuts, if there is any possibility of springing either tool or work the tendency is for the tool to ride upon the unfinished surface more or less and thus do an imperfect job.

Nothing dulls a tool faster than this riding over the work and trying to scrape the surface. A sharp tool is not so likely to do this as one already slightly dulled. Evidently, then, it is desirable to keep the tool sharp when doing this kind of work—that is, when cutting a thin chip. With respect to this, however, there arises the question of how often it is profitable to grind the tool. Evidently frequent grindings are economically undesirable in that they occasion the loss of much time. The paradoxical alternative is to give the tool more work to do —that is to increase the feed or depth of cut, or both.

The philosophy of it is that a heavy cut puts the tool under a stress great enough to take up all the slack and spring in the circle of parts extending from the point of the tool, through the tool-holding device, the frame of the machine, and to the point on the surface of the piece machined where the tool does its work. Obviously an increase in feed alone does not necessarily overcome the difficulty, for if the cut be light it may still be possible for the work or tool to spring sufficiently to allow the one to scrape the other instead of cutting it. It is therefore better to give an increased depth to the cut also. This generally reduces, if it does not wholly eliminate, the lateral vibration and thus saves the cutting edge of the tool from crumbling, as well as increases the accuracy of the work.

It may sometimes be necessary, when this is done, to decrease the

speed somewhat, to reduce the total amount of work at the cutting point to the maximum which the machine will stand or pull, or which the nature of the work itself allows. The saving in scrap and time lost in grinding however much more than compensates for this.

The necessity for increasing the depth of cut raises another question—that of the extent to which it is desirable to rough forge or cast parts which are later to be machined. In the case of castings, whether of gray or malleable iron, the removed metal may be used again in the melting furnace with practically no loss; so that there is nothing particular to gain by molding these parts close to size. On the other hand, as already shown, it is desirable that they be oversized sufficiently to allow the finishing tool to get a good grip, so to speak, on the metal, and to make reasonable allowance for warping and imperfect coring. Excess of size beyond these requirements merely occasions the unnecessary eating up of power at the machine.

In finishing malleable castings, however, it is to be remembered that the skin is the toughest part, and that if this is removed to a considerable depth the casting loses much of its strength because the interior is not, like the surface, of a close, steely grain. It is quite safe, however, under ordinary circumstances, to take a finishing cut of 1/16 inch, which is also sufficient to give the tool a good hold. The same depth is ample in gray-iron castings, unless they be quite large or so peculiarly shaped as to warp easily or be likely to be badly cored, when suitable further allowance is to be made.

In the case of forgings, however, there is to be considered the possible additional cost of making forgings close to the ultimate size. As to the cost of making a forging, a little reflection and observation will show that no more time is required to size properly a drop or other die forging than to leave it over size. As a matter of fact, most such forgings must conform, in the parts not to be machined, to a fixed standard anyway; so that in this respect the portion to be finished can just as well as not conform to the conditions pointed out as desirable in the case of castings.

It is different with large forgings—those made to specifications, and mostly by hand. Here the time required for close forging becomes an important item—the closer the forging, the greater the time, relatively. For such work it is undoubtedly more economical to forge only approximately to size, and let a heavy machine "hog off" the superfluous metal from those parts which are to be finished anyway.

All that has thus far been said with respect to chattering and vibration applies to carbon-steel tools as well as to those of high-speed

steel; but the latter are affected even more than the former, so that the proper setting and grinding of tools is a matter worthy of serious attention. Just how a tool should be shaped or ground or set for a particular job, it would be absurd to say dogmatically. The proper relation of these points depends upon so many conditions that experience alone can determine what they shall be for any particular job or class of jobs. About all that can be said at present, in a general way, is that for cast iron and similar materials, it is better to give the cutting tool less rake and more backing than is permitted in machining the more tenacious materials. In cutting steel the highest efficiency is obtained (the work, the tool, and the holding arrangement being sufficiently rigid to allow of it) by giving the cutting edge a rather sharper angle than has heretofore been customary.

These considerations would indicate that the re-grinding and re-setting of tools should be done with care greater than that which can usually be given in the average workshop. That is to say, for many kinds of tools it is not good practice to allow them to be ground at haphazard on the shop emery wheel, by the workman using them. Lathe and similar tools having but a single cutting edge, the angle of which may vary slightly without material disadvantage, may well be so handled. But the case is different when there are several cutting edges, as in drills, reamers, and milling cutters, whose efficiency depends among other things upon the uniformity of those edges and the consequent equality of work required of each.

Reamer grinding, for instance, is usually done by the workman using the tool. All the apparatus he has is an emery wheel and a rest to support the tool while grinding. The cutting angle and evenness of the lips when ground are wholly dependent upon the workman's judgment and keenness of eye. Under the circumstances there is absolutely no chance that there will be any considerable uniformity in the lips, with the result that those ground away the least take deeper cuts when working and therefore do much more work than the others. Of course these lips wear away much more rapidly than the others, shortening the life of the grinding and sometimes unfavorably affecting the accuracy of the work. In the case of a milling cutter any such irregularity would obviously be manifest in the milled surface. Good practice therefore indicates that for this class of tools at any rate it is desirable to arrange a system whereby they may be ground in the tool room; or if not there, anyway by some one provided with suitable appliances for duplicating a given edge with uniformity.

As previously pointed out, hot alloy steel must be kept from contact

with water, otherwise it will be checked and cracked very much as glass is under similar circumstances. It is therefore unsafe to allow the ordinary workman to grind such tools except on a dry grinder. It is true that the maker of certain high-speed tools insists that the inserted teeth must be ground on a wet wheel. But the condition under which this is possible is a thorough flooding of the wheel and a very gradual feed against the wheel. The slightest crowding will heat the tool in spite of the flooding, and the result is a spoiled edge, which crumbles under the stress of its work.

Even on a dry wheel the average workman will be very likely to spoil the tool because he all but invariably crowds it against the wheel and very quickly heats the edge unevenly, so that microscopic checks are developed which may later cause it to crumble easily. This is not however a thing that cannot be prevented, and dry grinding is generally the only safe method. If wet grinding is for any reason desirable or necessary, soda or soap water should be used.

Often there is considerable trouble with high-speed tools just when starting them to work, especially in small ones. Within a few minutes of starting, the tool may break or, more likely, show a crumbled edge. The reason is that high-speed steel is much tougher when moderately hot than when cold. A hot tool therefore will stand more work than a cold one, especially if the cutting edge have a rather sharp angle. If the tool be started at ordinary speed, with comparatively light feed, and gradually worked harder and faster for a few minutes, it will quickly "warm up" to its work, with no likelihood of breakage or impaired cutting edge. In larger tools, or rather in those having considerable metal close to the cutting edge, such disintegrating action is unusual, even if they are started without a preliminary "warming up." In all cases however, a little caution does not go amiss.

The matter of lubricants and cooling agents for use with high-speed tools has been previously considered (in the first article of this series) and therefore need not be again discussed in this place. It is perhaps sufficient to repeat that lubricants are usually unnecessary and cooling agents superfluous, when cutting steel as well as castings. If for any reason it is desired to make use of them, the usual soda or soap water will answer. Oil does no harm—and little, if any, good.

THE OCCURRENCE AND DEVELOPMENT OF THE COBALT ORE DEPOSITS.

By J. A. Macdonald.

The Cobalt ore deposits are among the most interesting now engaging the attention of the mining world. Mr. Macdonald has spent the past twelve months prospecting and surveying in northern Ontario, and his review of the field is based upon his own study and observation, though in the more technical portion, and especially the mining geology, he draws his data in part from other sources and authorities and is under obligations particular to the Ontario Provincial Government reports, to Professor Nichol, of the Kingston School of Mines, and to the Geological Survey Department.—THE EDITORS.

THE Cobalt ore bodies, which carry values in silver, cobalt, nickel, and arsenic, were discovered during the building of the Temiskaming and Northern Ontario Railway. In fact, it may be said that the railway discovered the deposits, as it runs almost over the top of what is probably the most important vein yet found. The finding of ore so rich within a short distance of the shore of Lake Temiskaming, a stretch of water which has been a well-travelled route to the North by white men for two hundred years or more, and the existence of the deposits only about four miles from the town of Haileybury, show the possibilities there are for the discovery of important mineral-bearing areas in the vast hinterland of Ontario, much of which is little known. The chief of these ore bodies which have been worked lie within half a mile of what is now known as Cobalt station, distant by rail about 103 miles from North Bay junction on the Transcontinental line of the Canadian Pacific, and 330 miles almost north of the city of Toronto. It may also be added that one of the oldest known ore bodies in North America, the argentiferous galena on the east side of lake Temiskaming, is distant only 8 or 9 miles from Cobalt station. This galena deposit was apparently discovered by voyageurs over one hundred and fifty years ago. A map of the lake published about 1778 has a bay marked on it with the name "Anse à la Mine" thus showing that the deposit was known at least at that date and probably much earlier, owing to the fact that the ore outcrops at the water's edge and is of such a character as to attract attention.

Some of these veins in the vicinity of Cobalt station were apparently noticed by the men employed in railway construction in the spring of 1903, but, there being no miners or prospectors among

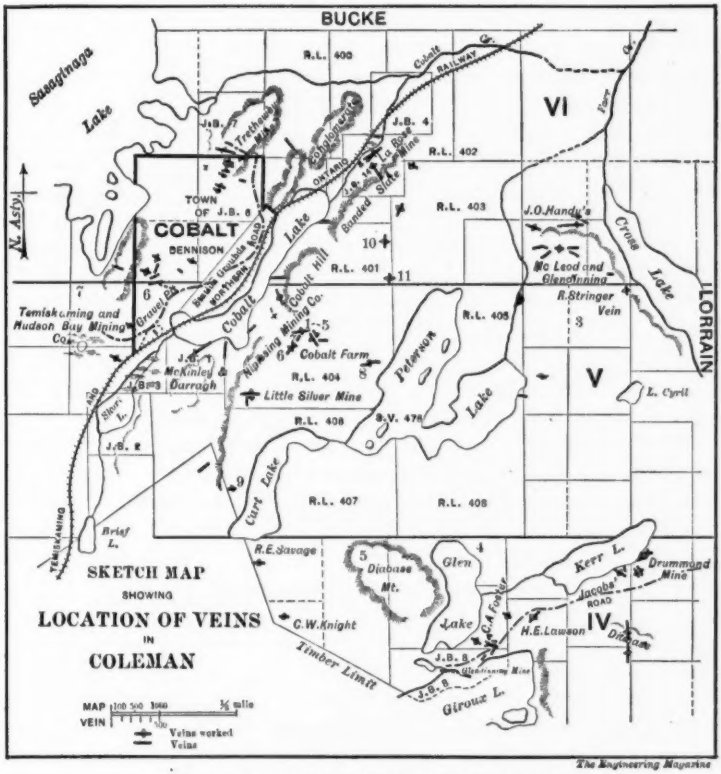

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FIG. 1. SKETCH MAP OF THE COBALT REGION.

Following one presented in the Fourteenth Report of the Bureau of Mines.

them, little interest was aroused and nothing was heard of the discovery by prospectors until October of the same year. At that time Mr. T. W. Gibson, director of the Bureau of Mines, then in that part of the Province, was given a sample of niccolite which the donor thought was copper ore, the color of this mineral being like that of copper as the German name, *kupfernickel,* indicates. This mineral niccolite had been found some years before in association with the lower grade nickel ores of some of the Sudbury deposits, but no great quantity of it has up to the present been discovered in the Sudbury field, the town of which name lies about 90 miles southwest of Cobalt station. The deposits at Cobalt, on the other hand, occupy narrow, practically vertical fissures or joints which cut through a series of

usually slightly inclined metamorphosed fragmental rocks of Lower Huronian age. A few veins, of similar form, have also been found in the adjacent diabase. Some of the recently discovered veins near the centre of location R. L. 404 (page 407) appear to be partly or wholly in the Keewatin, which is here in contact with the Lower Huronian.

The material in these veins has, in all likelihood, been deposited from highly heated and impure waters which circulated through the cracks and fissures of the crust and were probably associated with the post-Middle Huronian diabase and gabbro eruption. It is rather difficult to predicate the original source of the metals—silver, cobalt, nickel, arsenic and others—now found in these veins. They may have come up from a considerable depth with the waters or they may have been leached out of what are now the folded and disturbed greenstones and other rocks of the Keewatin. Analysis of various rocks of the area have not given a clue as to the origin of the ores. As these ore bodies in the vicinity of Cobalt station may be said to be unique among those known in North America we have no chance of instituting comparison on the western continent. Some European veins, however, such as those of Annaberg, Joachimsthal and other localities show a similar association of minerals. The origin of these has been explained by most authors by the supposition that the metals were leached from the surrounding rocks. From the descriptions which have been published of most of these European occurrences, it appears that there are usually basic dikes in the vicinity of the veins. These dikes appear to have, in some cases, the same relation to the ore bodies that those of diabase and gabbro have in the Ontario cobalt region.

Ores.—The chief ores are native silver, smaltite or diarsenide of cobalt, niccolite or arsenide of nickel, chloanthite or diarsenide of nickel, associated with which are argentite or sulphide of silver, pyrargyrite or sulph-antimonide of silver, dyscrasite or antimonide of silver, erythrite or cobalt bloom, annabergite or what may be called nickel bloom, millerite or sulphide of nickel, native bismuth, tetrahedrite or sulph-antimonide of copper and other metals, mispickel or sulph-arsenide of iron, and occasionally graphite. Erythrite and annabergite are the hydrated arsenates of cobalt and nickel respectively. They are both decomposition products. Asbolite and other minerals of similar origin are present. The more common minerals, galena, copper pyrites, iron pyrites, and zincblende, together with oxide of manganese, occur in small quantities, especially in the country rock. Other minerals are found, but generally in such an impure form that

their characters have not been definitely determined. Calcite is the chief vein stone, but some of the veins have little even of it. Quartz and fragments of the wall rock are found in some of the ore.

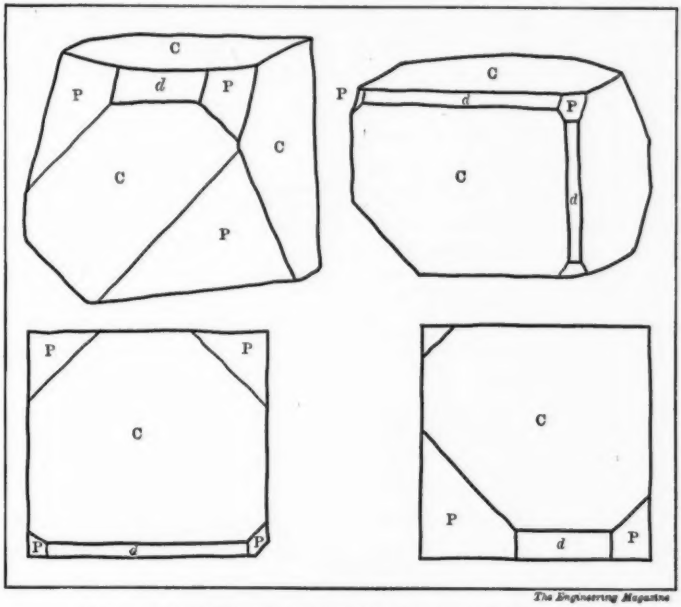


FIG. 2. SMALTITE CRYSTALS FROM THE COBALT HILL MINE.
C, cube; P, Octahedron; d, rhombic dodecahedron. After Professor Nichol.

The outcrops of the veins usually show native silver and cobalt bloom. The latter is a good indicator, its delicate pink color having a striking appearance. It is apt to be confused only with certain tints of red oxide of iron. If the bloom is, however, carefully heated, which can be done in the cover of a tin can over a camp fire, it will be found to turn blue. If fused with borax it imparts a beautiful blue color to the resulting glass. The native silver exposed at the outcrops will, of course, be tarnished. Its color can be determined by cutting it, and its weight is characteristic. Native bismuth, with fresh surfaces, looks like silver, but is more easily cut, and on exposure tarnishes a reddish color. The other important mineral in the above list which is not brittle and is easily cut is argentite. Prospectors have mistaken it for lead, but it is black in color.

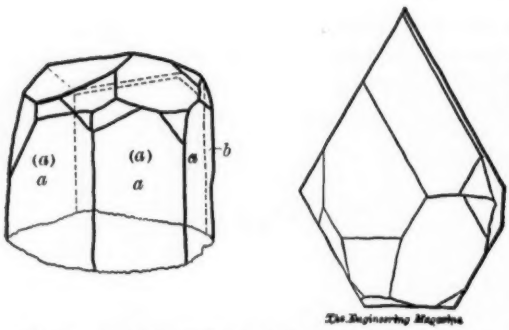


FIG. 3. PYRARGYRITE CRYSTALS FROM LA ROSE MINE.
"The crystals occur as an incrustation on the surfaces of chinks or cracks in the country rocks intimately associated with argentite or silver glance.—PROFESSOR NICHOL.

The veins are narrow (the width of the ore averaging in the veins which have been worked, probably 10 or 12 inches) and may be easily passed over by those accustomed to prospecting in other fields. Fragments of rock should be frequently broken off the ledges. Bloom has been discovered by this means in outcrops where its presence was not suspected. Cracks in rocks should be cleaned out with a prospecting pick. A vein of these ores, a few inches in width, is worth much labor.

Shipments.—From five veins which have been opened up during the last few months, in an area which is less than one mile in length from north to south and about one-half mile in breadth from east to west, surrounding Cobalt station on the recently constructed Temiskaming and Northern Ontario Railway, something like $400,000 worth of ore has been shipped. With one exception—the vein on the north of R. L. 404 near Cobalt lake—all these veins carry high values in silver, besides important amounts of cobalt, nickel and arsenic. The composition of shipments (carloads) from one of the silver-bearing veins (1), and from the vein which does not carry silver values (2) is seen from the following results of analyses:

(1)	Per cent	(2)	Per cent
Silver	11.41	Cobalt	15.60
Cobalt	11.27	Nickel	7.00
Nickel	3.78	Arsenic	61.74
Arsenic	44.16		

Silver brings about 60 cents per Troy ounce, and about 90 per cent of the value is paid for the metal in the ore. Cobalt has sold for 60 to 65 cents, nickel at 12 to 15 cents, and arsenic at about 1 cent a pound in the ore.

The Cobalt-Silver Veins.—It is considered unnecessary to give a detailed description of each vein in the district, the character of one being usually so much like that of another. Many veins have recently

been discovered, especially on the older properties. Scarcely any of the veins have been stripped for their full length. Most of those worked have been developed in the form of open cuts. The vein first discovered on the La Rose claim J S 14, on which several others have since been found, has been developed more systematically than any other in the district. A shaft has been sunk and about 250 feet of drifting has been done at the 90 foot level, following the vein in both directions from the shaft. The drifts prove that the vein is at least as large and as rich at this depth as it has ever been. In the 250 feet the drifts have passed through comparatively little barren ground. Approximately $1,000,000 worth of ore has been blocked out on this vein. The ore body here is one of the largest developed in the area, but the Nipissing company is the largest mining property in the field and promises large-scale operations. The La Rose ore differs somewhat from that of the other veins in that it contains a higher percentage of niccolite, the nickel averaging about 10 per cent.

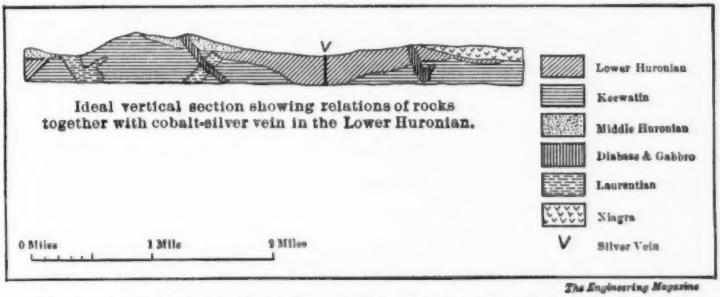


FIG. 4. A TYPICAL GEOLOGICAL SECTION SHOWING THE OCCURRENCE OF THE SILVER VEIN.

To give an idea of the character of the ore of one of the other veins it may be said that an open cut, about 50 feet long and 25 feet deep, on the Tretheway vein, location on plan, J. B. 7, has produced approximately $200,000 worth of ore, the maximum width of the vein being not more than 8 inches. The amount received for one car load of 30 tons of ore from this mine, at the prices for the contained metals mentioned elsewhere in this review, was between $75,000 and $80,000. A shipment of 50 tons of the ore gave on analyses approximately the following percentages of metals: arsenic, 38; cobalt, 12; nickel, 3.5; and 190,000 ounces of silver. Pay was received for cobalt and silver only.

Most of the cobalt-silver veins occur in what is called the Lower Huronian. A few have been found in the diabase. There is no

reason so far apparent why the veins should not also occur in the underlying Keewatin, and some of the more recently discovered ones, near the centre of location R. L. 404, appear to be in this group.

The more important veins so far found in the Lower Huronian lie in what may be called three parallel belts. Those first discovered are in a belt which runs about parallel with the railway in the vicinity of Cobalt Lake. A small belt connects the northeast corner of Peterson lake with the northwest corner of Cross lake. A third belt stretches from Giroux lake to the southeast end of Cross lake, in which important deposits occur. These three belts have a strike approximately in a northeast and southwest direction.

Dimensions.—The veins are all narrow. The ore in the Tretheway vein on J B 7, for instance, had a maximum width of about 8 inches, while the vein in the northwest corner of R L 404 has 14 inches of ore, and that on J S 14 showed about 18 inches. Some veins which have been traced 100 feet or more average not more than 1 inch in width.

The surface, being uneven and more or less covered with loose deposits and with green timber, does not afford an opportunity of tracing the outcrops of the veins any great distance, and it is not known definitely how long most of the outcrops would prove to be if the material referred to were removed from the surface of the rock.

It is also impossible to give much definite information concerning the depths to which these veins will reach. As already said, most of them do not appear to cut through the older Keewatin series which forms an uneven surface below the Lower Huronian. In the vicinity of Cobalt station the latter rocks are found on hilltops which stand about 500 feet above the low-water level of Temiskaming where similar outcrops are found.

The depth to which a vein may reach depends, therefore, on whether it descends into an old valley of the older rocks or whether it lies above a former hilltop.

One shaft is already 70 feet, another 90 feet, while a diamond drill has been driven 340 feet into La Rose, and in each instance pay streaks held out. Inasmuch as the camp and the ores found here are new things in the mining world, scarcely any man knows or can know the extent of the find until the whole district, including the northern watershed, has been prospected. In the meantime Nature has been so generous it seems she should be trusted so long as the pay dirt lasts. In a space of 25 feet and 50 feet long in the Tretheway mine, as much as $200,000 worth of silver ore has been extracted.

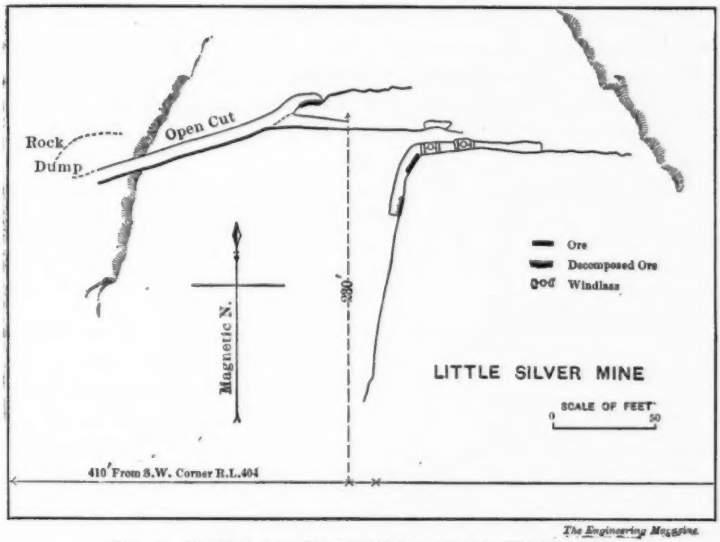


FIG. 5. SKETCH MAP OF WORKINGS, LITTLE SILVER MINE.

So far as surface indications, real nuggets, and ore in sight, are concerned, Cobalt is the richest silver camp on the continent. Cobalt is intoxicating. It is so fabulously rich in silver that men are apt to fancy they can go up to the new camp, strike a claim, and begin shipping ore. But it is not quite so easy as that. The prospector going to Cobalt should be prepared to travel the rough unbroken trail. There are also lakes and swamps and great wide rivers, cold and damp, and many other obstacles.

Distribution of Ores.—A peculiar occurrence of cobalt and nickel with gold has recently been discovered on Rabbit lake, east of Temagami and about 30 miles south of Cobalt station. The outcrop is at the water's edge and the deposit has not been uncovered back from the shore. The rocks here have been more disturbed and are much more highly metamorphosed than are those in the vicinity of Cobalt station. They appear, however, to belong to the Lower Huronian conglomerate-greywacke series. The ore body, about 18 inches wide, is in a zone fracture. An analyses of some of the more highly mineralized material gave the following results:

Arsenic	22.53
Cobalt	8.76
Nickel	6.56
Gold	$8.80 a ton.
Silver	1.10 "

This unique deposit is of interest since it shows that cobalt-nickel ores are to be looked for so far south of Cobalt station. The Rabbit lake occurrence is about the same distance south of Cobalt station as the ores of the township of Ingram are north of it, thus showing that the cobalt-nickel ores are distributed over a distance of at least 60 miles in a north and south direction.

Mining claims are numbered on the map thus: J. B. 1, R. L. 400, etc., the initials representing the surveyor's name. Mining claims 40 acres in size on lots which were surveyed prior to the location of the claims are not numbered, but their boundaries are shown on the map. (See page 407.)

Character of Surface.—Most of the southern half of the mapped area contains green timber. Lumbering operations have been conducted over all this area with the exception of the Lumsden & Booth timber berth. Much of the field is covered drift deposits, and the exposures of compact rock are frequently clothed with moss. In the field it is difficult at times, to distinguish these greenstones from the slaty-greywacke member of the Lower Huronian, especially if the latter has been subjected to pressure. Only a rapid traverse was made through the timber berth which lies immediately to the east and to the south of the Montreal River. The surface is uneven. Hills with steep faces frequently rise to a height of a hundred feet or more.

Prospecting.—A prospector entering the district in search of cobalt-silver deposits should first make himself familiar with the various classes of rocks, otherwise he may spend his time on the least promising outcrops. Good exposures of the Keewatin greenstones are to be seen along the shore of Lake Temiskaming immediately to the south of Haileybury, and along the line of railway between Cobalt lake and Bass lake. The latter exposures contain numerous small cracks filled with white calcite, which assist in distinguishing these rocks from the near-by rather massive greywacke slates of the Lower Huronian. A typical variety of the diabase or gabbro, later in age than the Huronian, is to be seen in the first rock cut on the railway south of Haileybury. Between this cut and Cobalt station there are several exposures of the conglomerate, with granite and other pebbles, and of the slate-like rocks of the Lower Huronian. A good contact between the latter series and the Keewatin with porphyry dike, is exposed on lot 15, concession 11, of Bucke, on the shore of Temiskaming. The Lower Huronian here rests on Keewatin and contains pebbles and angular fragments of greenstone and porphyry, thus clearly showing the unconformity between the two series. A

contact of the Lower Huronian with the Middle Huronian is to be seen on lot No. 4, concession XII. of Lorain. Angular blocks, or shingle, of the former are cemented in the arkose of the latter.

The terms Lower and Middle Huronian are here used provisionally. The formations have not been correlated with those to which the names are applied in the vicinity of the north shore of Lake Huron and elsewhere.

A great variety of minerals is found in the veins, and the prospector should visit some of the working properties near Cobalt station and become acquainted with the general character of the ore.

Investors Flocking In.—Gentlemen from New York in Newmarket coats rub elbows with others from San Francisco, Chicago, and Detroit, while several Montreal and Toronto syndicates have had men upon the scene quietly picking up promising properties wherever they may be obtained. Two mines in Coleman township are owned and operated by Montrealers, the Drummond and Jacobs mines. These two lie side-by-side on Kerr Lake, about three miles southeast of the camp, and almost directly east of the famous Diabase Mountain. Nearby on Giroux lake, is the famous University (or Glendenning) mine.

A couple of young graduates from the School of Science, Toronto, were surveying in the neighborhood about the time the original strikes of silver were made. They immediately did some prospecting, and as a result located the mine mentioned. As high as a million and a half has been offered for it and refused. In appearance these mines at first, like all the others, disappoint the uninitiated. The approach to them is interesting enough.

One drives for a couple of hours over a winter road, grazing stumps and tree trunks and passing groups of prospectors who, with pick and "steel" upon their backs, are setting out, in spite of the snow, to their claims On every side from the working claims comes the noise of blasting and the ring of iron on steel, as the miners prepare for a "charge."

Precipitous hills, almost impossible to climb, give one an instant reward when finally the top is gained. For miles and miles the forest stretches away toward Lake Temiskaming, the intervening country dotted with a dozen tiny lakes. Then a clump of frame buildings is seen. One is the "bunk-house," where the miners sleep; another is a "grub-house", where they eat, while off, at some little distance, stands a frame building, with a long smoke stack protruding through its roof.

Inside the building all that is seen is a yawning hole topped by a windlass to raise the ore bucket. A small engine operates the windlass. There comes a whistle from the depths, and in a few seconds a huge bucket filled with pieces of dirty-looking wet rock is dumped upon the floor of the shaft house. Loaded into a wheelbarrow, it is carried to the ore house, where a couple of men break it into smaller lumps and bag it in rough sacks. It is only when a piece of the dirty-looking rock is handled that one realizes its value. Upon the broken surface of the piece of rock one sees a myriad of little bright specks. If you rub your finger over it they prick it. "Three thousand dollars to the ton," the captain of the mine will remark, as he handles the chunk with a knowing air.

The Cobalt district is soon to have a great ore smelter and refinery. It will cost $60,000, and the Ontario government has agreed to give the projectors a free site on the Temiskaming railway, between Cobalt and North Bay. The smelter and refinery is expected to be in operation in October next. The great trouble with the cobalt ores heretofore has been the problem how to smelt them without wasting one or other of the metals or minerals contained. Silver, cobalt, arsenic and nickel are all present in considerable quantities in most of the ores, and the mine owners were getting nothing for some of the products at the smelters in New Jersey, where all the ore so far has been sent. The projectors of the Cobalt smelter turned to Germany for an object lesson, and found that for five centuries Saxon ores have been successfully treated which contain cobalt, arsenic and silver. The process is a secret one, but an arrangement was come to by which a license is granted to carry it on in Canada on condition that the process shall be in charge of two German experts to be sent out by the Royal Geological Institute of Berlin. One of these gentlemen has arrived, and surveyors have lately located the site of the smelter. So far only the silver has been paid for, and nothing has been received for the cobalt, nickel, and arsenic. When this smelter gets working, it is the intention to pay for all the products recovered from the ore at a regular fixed tariff. The total output from the Cobalt mines for 1905 was in the vicinity of $2,000,000.

EDITORIAL COMMENT

THE report of a majority of the Senate Committee on Interoceanic Canals, favoring a sea-level project, marks a new stage in the preparatory consultations; we greatly fear it will prove the inspiration to further delay rather than to immediate physical progress. The slender majority in committee can scarcely carry their recommendation through against the firm conviction in favor of the summit-level project which preponderates in the judgment of the Administration, of all but one of the Commission, of the chief engineer, of (it is said) a large majority of the House of Representatives, and of (we believe) the greater part of the engineering authority of the country, whether represented by the technical press or by individuals. Some notable exceptions to this last category must be recognized, among whom the former chief engineer, Mr. John F. Wallace, stands high in honorable distinction.

Anyone who followed the testimony before the committee can well understand that the volume of matter presented and the honest divergences of opinion between various witnesses might—nay, probably must—produce much perplexity in the minds of laymen unqualified to weigh the authority of the several engineers appearing before them, or in some instances to distinguish between professional opinion and personal animus in the testimony given. The impressive confidence of certain of the witnesses seemed to be in inverse proportion to their authority in, or experience and familiarity with, the very special questions involved. Worse yet, the evidence offered in other instances was—to the shame of the profession be it said—distinctly unfair. Add to these disturbing influences that of a sudden and as yet ill-digested impression from the San Francisco earthquake, and one seems to have a pretty good conspectus of the controlling influences behind this report.

Awed by bogeys and confused by irrelevancies and mares' nests, the majority turn with a sense of secure relief to the comfortable phrase "sea-level." Why? Because they fear an earthquake might "fracture the locks" of the summit-lake canal. But the so-called sea-level canal would also have locks, at Sosa, subject to similar fracture. Why next? Because they fear the possible failure of the Gatun dam, sustaining the summit lake at a level of 85 feet above the sea. But the so-called sea-level canal would be absolutely dependent upon the Gamboa dam, holding the Chagres in a great lake 180 feet above the sea, and almost overhanging the canal. Truly, there is much in the names given to things. To the sentiment carried by the image of a true sea water way, we believe, is due in large part the majority decision in favor of a project which, in our best judgment, really affords the poorer solution of the engineering problems involved and the least efficient medium for the uses of navigation. Neither in its tenor nor in its expression does the majority report add much to the world's wisdom in the matter of the Panama Canal.

* * *

It is sincerely to be hoped that the overwhelming majority by which the House passed the Free Alcohol Bill will be taken to heart by the Senate as voicing the National appreciation of the importance of the measure, and the public demand for its passage. At the outset, however, it seemed to encounter there an opposition which, in view of its source, was universally attributed to

the Standard Oil interests. Their objection to anything which held the prospect of breaking their monopoly over the market for fluids suitable for burning in lamps, or for use in internal-combustion motors, was held to be not indirectly related to the efforts made to reopen entirely new hearings in the Senate, and generally to make it impossible for the bill to reach passage at this session.

Rather hastily and at least semi-officially, however, it was denied on the part of the Standard Oil Company that they had any desire to retard the bill or any interest whatever in it, one way or another. Probably the history of the "Octopus" does not encourage confidence in its sincerity in any policy so broad-minded as this would imply; but unquestionably there is unlimited room for the industrial use of alcohol without prejudice—indeed, with ultimate advantage—even to the sellers of oil and benzine. In any case, it is now announced that the bill has been favorably reported to the Senate by the Committee, with some amendements as to penalties only. Each one may draw his own conclusion as to how far this result was influenced by the flare of anger which swept across the country when the obstructive policy of Senator Aldrich was first reported. The temper of the people towards the Standard Oil Company is not such that it would be wise to fan it by further agitation.

Rarely, indeed, does any economic legislation open so many doors of opportunity as this. The puzzle is that the Nation has so long been blind to its own interests. We do not generally look to Germany for greater industrial alertness than we find at home, but she has long led us in this particular field. By recent reports, there are in the German Empire now more than five thousand internal-combustion motors in use in stationary power plants, running on denaturized alcohol, besides all those employing the same fuel on automobiles. And this is only one of the directions in which cheap grain alcohol would benefit industry. Not the least, as we remarked in a recent issue, is the relief of thousands of workers from the deadly poisoning effects of wood-alcohol fumes—an evil almost comparable to the long-denounced and practically outlawed phosphorus and mercury diseases. And every use found in the industries or arts means added opportunity for agriculture. Nothing should be permitted to stand in the way of the passage—and the speediest possible passage—of the bill now in the Senate.

* * *

We have already referred in these columns to the comparative uselessness of automobile races, so far as the improvement of the mechanically propelled vehicle is concerned; since the qualities which conduce to high speed bear comparatively little relation to reliability, efficiency, or convenience. It is interesting to note that this view is being generally shared both in Europe and in the United States by the various organizations having control of automobile trials, and following the initiative of the Automobile Club of France, the different associations are giving attention to various reliability tests.

One of the most interesting of these tests is undoubtedly that conducted last month by the Automobile Club of America upon the efficiency of gasoline motor cars, the basis of the test being the effective energy developed by the consumption of two gallons of gasoline.

Such a test is valuable for several reasons. The amount of fuel corresponds to that which can be conveniently carried by an ordinary light vehicle, so that the results are of immediate interest to the whole body of automobilists. By measuring the charge of fuel beforehand, all necessity was removed for using any refined methods of testing fuel consumption during the run, the quantitative results being determined simply by noting the distance run, the

control being effected automatically by the exhaustion of the fuel supply. Each machine also received a rating based upon its powering and load, so that nothing further was necessary than the statement of the distance traversed, a quantity capable of being checked at any time thereafter beyond possibility of controversy.

The results of the trials proved beyond doubt the value of such tests by the wide-spread interest with which they were received. The winning car, the Franklin, carried two passengers for a distance of 87 miles before the two gallons of gasoline were consumed, while results not far short of this were attained by other vehicles. In order to show that the result obtained by the winning car was not due to any special circumstances, the same machine was given a second independent test, in which it covered 95 miles upon a fuel supply of two gallons of gasoline, so that the figures appear to be reliable. It is considered significant that out of the five cars which covered the greatest distances in these trials, four were air-cooled, demonstrating the fact that water-cooling is not necessary for practical road vehicles.

* * *

The development of the ocean steamship goes on apace, and the record tenure of each "greatest vessel afloat" appears to be briefer than ever. Hardly has the giant *Amerika* made her maiden trip than her still bigger sister, the *Kaiserin Auguste Victoria* leaves Hamburg for New York. The latest of the "greatest" ocean liners has a length of about 700 feet, a breadth of 77.6 feet, and a depth of 54 feet, the total displacement being 43,000 tons, with a gross register of 25,500 tons.

It is interesting to note that vessels of this type are exceedingly popular with the traveling public. Equipped in all respects as elaborately as the most magnificent of modern hotels, and providing for every comfort and convenience for the passengers, vessels of the type of the *Amerika* or the *Auguste Victoria* go out with full passenger lists at rates which are both possible to the general traveller and profitable to the company. The capacity of such a steamer will be appreciated better when it is understood that the *Auguste Victoria* carries 550 first-class, 300 second-class, and 2,300 steerage passengers; and, including the crew of 650, this floating city carries very nearly 4,000 people, the population of a considerable town. The speed is such that the crossing from England to America is accomplished within a single week, and there are few who will find this time too long to spend upon such a stable, safe, and complete vessel. Speed may be necessary for the rapid handling of the mails, and for the convenience of those to whom the sea is a source of discomfort and dread, but with the increase in dimensions and stability, this latter class is rapidly diminishing in numbers. Apart from the large economy effected by the lower powering which the moderate speed makes possible there is also gained valuable cargo capacity, the *Auguste Victoria* being capable of carrying 16,000 tons of freight.

* * *

The Chattanooga meeting of the American Society of Mechanical Engineers may be considered as a success in many ways. The historical associations and the scenic beauties of the location, together with the cordial welcome extended to the visitors, combined to render the four days most agreeable to those who were privileged to attend the meetings, while the papers presented and discussed were worthy contributions to the Transactions of the Society.

We have reviewed elsewhere in this issue the important series of papers upon the speed regulation of various kinds of water-wheels, and among other contributions to the Transactions we may here note the most important series of

investigations by Professor Stewart upon the collapsing pressure of lap-welded steel tubes. As a consequence of these experiments the author has been able to derive a formula representing the facts with a far higher degree of accuracy than has hitherto been the case, and there is little doubt that the older rules and formulas will become obsolete, and replaced by the one which these investigations produced.

Among the excursions provided by the local committee for the entertainment of their guests, the most important, from an engineering viewpoint, was that to Hale's Bar, below the city of Chattanooga on the Tennessee river, where there are under construction important improvement works, including a dam to aid in the navigation of the river, together with the development of 50,000 horse power of energy, for electrical transmission to Chattanooga and vicinity.

The membership of the Society in the vicinity of Chattanooga is but small, but it is a pleasant experience with these midsummer meetings that they are almost invariably followed by welcome additions to the membership from the locality where the meeting is held.

* * *

In this connection it may be a matter for note that there are many reasons why, at this time, the membership of the American Society of Mechanical Engineers should be largely increased. At the present time there is a total membership of about 3,000. That this represents all the engineers in the United States who are eligible for membership, cannot be admitted. There are many men who, by training, experience, and general qualifications should associate themselves with this National society, and both receive the benefits which membership will confer, and give of the experience and ability which they possess, to the advancement of the profession in this country.

By the close of the present year the Society will enter upon the occupancy of its share of the magnificent Union Engineering Building which, through the generosity of Mr. Andrew Carnegie, one of its honored members, the Society is one of the founder societies. With this change in its location the Society is destined to grow still more rapidly in the future than it has in the past, and notwithstanding the rigid professional requirements which are demanded for membership, it is destined to include in its roll a far greater number of the engineers of the country than has hitherto been deemed possible. Not to be a member of the American Society of Mechanical Engineers, when one is by education, experience, and general ability fully qualified, is to fail to appreciate the opportunity which exists to grasp the highest standing which the profession offers; it is to miss the ultimate goal which should be the aim of every man who believes in the advancement of his own share in the applied science of engineering.

* * *

On the 27th of April last the Committee on Coinage, Weights, and Measures, of the House of Representatives, decided, by a vote of 8 to 4, not to report favorably on the Littauer bill for the compulsory introduction of the metric system of weights and measures into the Departments of the Government, and thence into all workshops.

This disposes of the question for the present Congress, but it will be necessary for continual vigilance to be exercised against the schemes of those who are endeavoring to slip some additional metric legislation through Congress.

Every American manufacturer and engineer should be on his guard to see that none of the underground methods which have been adopted in the past shall fail to be checked, until this insidious movement is absolutely dead.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE GAS TURBINE.

A REVIEW OF THE THERMAL AND MECHANICAL CONDITIONS UPON WHICH THE PRACTICAL SUCCESS OF THE GAS TURBINE IS DEPENDENT.

L. Sekutowicz—Société des Ingénieurs Civils de France.

THERE has been observed of late in various quarters a disposition to disparage work upon the gas turbine and to indicate that while the question might be all very well for mathematicians and laboratory scientists to use to occupy their time, it could not possibly interest the practical man. That this is not the opinion of some very competent engineers, however, is beginning to be realized, and there is no doubt but that, at the present time, there are a number of patient investigators as well as thorough scientists who are fully convinced that the gas turbine, before very long, may bear the same relation to the reciprocating gas engine as the steam turbine does to the older forms of the steam engine.

In a recent issue of the *Mémoires* of the *Société des Ingénieurs Civils de France* there is given a paper presented before the society by M. Sekutowicz, discussing the whole subject of the gas turbine, from a historical, thermodynamic, and practical view, showing that important developments should be expected from the earnest work which is being given to this motor by the investigators who are working upon its practical development.

The term gas turbine includes such heat motors as are intended to convert heat into mechanical energy by the expansion of a gaseous mixture upon the wheel of a rotating turbine. The idea of thus utilizing the expansive forces of heat upon gases is very old; probably the most ancient application of the principle appears in the mediæval turnspit, in which a sort of propeller wheel in a chimney was caused to revolve by the current of the ascending gases, this motion being transmitted by chain or other gearing to the spit upon which the roast was revolved before the fire. In the modern sense, however, probably the first gas turbine was that devised by M. Burdin, who, in 1847, proposed to construct a sort of hot air turbine, operated by the flow of heated air through a multiple-wheel turbine, the supply of heated air being kept up by the action of a similar set of multiple blowers.

The real beginning of modern turbo-machines, both for gas and steam is undoubtedly due to the communication of the French engineer, Tournaire, to the French Academy in 1853, in which he discussed the multiple-wheel turbine in general, and evidently realized the difficulties which were involved on the perfection of the gas turbine, but also said that its success would include a revolution, not only in the quantity of combustible consumed, but also in the equally important reduction in the masses of material involved in the construction of such machines.

Coming down to the actual conditions involved in the problem of the gas turbine, M. Sekutowicz shows that such machines may be classified according to the manner in which the heat is carried through the cycle.

Thus, there may be employed the Carnot cycle, and its derivatives, as already used in reciprocating motors by Diesel; the principal difficulty with this being the high de-

gree of compression required to secure the approximate cycle.

The second method is that of using the isobaric cycle, corresponding to that used by the so-called combustion motors. This involves the use of an isothermic compression carried up to 30 or 40 atmospheres rejecting adiabatic compression.

The third cycle is defined by M. Sekutowicz as the isopleric cycle, being a cycle of constant volume, corresponding to that of the explosion motor. Theoretically this should give the same results as the isobaric cycle, with the advantage of requiring a much smaller compressor, but its application to the gas turbine appears problematic.

In practice the compressor offers the principal difficulty, and upon its efficiency the relation of total to the useful work largely depends. As a matter of fact the gas turbine is a machine characterized by a high thermal efficiency and a low mechanical efficiency, but M. Sekutowicz believes that it is capable of showing a net efficiency fully equal to that of the Diesel motor, by far the most efficient heat engine which has yet been produced.

The author shows that with the gas turbine, as with the reciprocating internal-combustion engine, the best result should be attained with high compressions, by the rapid introduction of heat (about 500 calories per kilogramme), and by an exhaust temperature of about 700 degrees C., absolute, and he then proceeds to discuss the mechanical arrangements by which these conditions may be most nearly approximated. Various auxiliary appliances have also been suggested, of which M. Sekutowicz discusses the following. Regeneratives cycles have been employed, in which the heat of the exhaust gases has been used to give a preliminary heating to the compressed gases before delivery to the combustion chamber. In this way a machine may be made with an improved thermal efficiency without modifying in any way the mechanical efficiency or the importance of the compressor. Another plan has been to prolong the expansion by using an exhaust pump to lower the exhaust pressure, but this does not improve the total performance.

Another auxiliary process is that of injecting water or steam into the acting gases. This may be effected in various ways. The water may be injected into the combustion chamber, or beyond the expansion nozzle. Water may be injected directly into the combustion chamber with a possible improvement in performance, but a far better plan is to inject high-pressure steam from a boiler heated by the exhaust gases. In this way, using a pressure of 40 atmospheres, M. Sekutowicz states that an efficiency of 0.26 may be increased to 0.34, other conditions being equal.

Another plan suggested has been to use the heat of the exhaust gases to operate a second machine, somewhat on the principle of the so-called binary vapor engines, but it has been found that better results are obtained in utilizing this heat in machines on the regenerative principle.

A study of the laws of the adiabatic expansion of gases in nozzles shows that the velocities of discharge are somewhat higher for gas than for steam, ranging from 1,500 to 1,600 metres per second for an exhaust temperature of 700 degrees C., absolute, so that the power obtainable from a given nozzle is greater for gas than for steam. In this connection M. Sekutowicz discusses the probable losses by friction, showing the methods for computing the mechanical efficiency of machines of this type, as well as the different manners in which the speed and power may be regulated.

The most interesting portion of the paper, however, is that relating to constructive details of gas turbines, including the compressor, the combustion chamber, the various systems for regeneration, and the rotating wheel itself.

The compressor is one of the most important elements in a successful gas turbine plant, since it is a negative charge upon the efficiency of the machine, and it is most desirable that it should have a high efficiency itself and be as simple and effective as possible. As a high efficiency of the whole plant is largely dependent upon a high compression of the charge the compressor must be able to compress the initial charge of air, or of air and gas, to about 40 atmospheres, the air and fuel charge being maintained in the combustion chamber at a pressure of about 10 atmospheres, and exhausted from the turbine

wheel at atmospheric pressure or below.

Of course it would be most desirable to have a rotary-air-compressor capable of delivering the air and fuel at the required pressure, but at the present time this has not been found practicable. Rotary compressors, based upon the same principle as multiple centrifugal pumps, have been designed, but it is with difficulty that such machines have been made to deliver air at a pressure of 20 to 25 atmospheres, the large number of wheels required, and the frictional losses caused by the revolution of the wheels at high speed in dense air, causing the efficiency to fall off below the best rate.

Reciprocating compressors are yet the most reliable, although it detracts materially from the advantages of a rotary machine to have a reciprocating machine attached to it, and for the present at least, this must be allowed. So long as efficiencies of 70 to 80 per cent are to be obtained from reciprocating compressors these will have to be considered, at least until some more efficient form of rotary compressor is produced.

The combustible used in a gas turbine may be solid, liquid, or gaseous, but, for the present it appears unlikely that solid fuel will be employed directly, owing to the injurious effects of the ash and non-combustible portion upon the turbine wheel. Solid fuel may best be used in a gas producer, the gaseous fuel being compressed and delivered to the combustion chamber in a manner similar to that employed for the air. The most successful work at the present time has been effected with liquid fuel, but there appears to be no good reason why compressed gas may not be employed with equal success.

Producer gas, the waste gases from blast furnaces, and all similar fuels are available for use in the gas turbine, and with the coming liberation of alcohol from the burden of repressive taxation, a new source of energy, of such wide-spread possibilities as to render it beyond the control of favored monopolies, will be released to become a source of power in combustion motors of all types, for the benefit of mankind.

The fuel, be it liquid or gaseous, is introduced, under pressure, with the air, into the combustion chamber, and this chamber should be of sufficient dimensions to insure a complete combustion, before the gases which are the products of combustion are delivered to the expansion nozzle. The velocity at the nozzle will vary from 500 to 800 metres per second, as the temperature of combustion ranges from 1,000 to 2,500 degrees centigrade, absolute. Since the velocity of propagation of flame at atmospheric pressure, is from 1 to 2 metres per second it is desirable to have the cross section of the combustion chamber about 100 times that area for a compression of 25 atmospheres and a temperature of 2,000 degrees absolute, since these conditions give a density of about ten times that of the exhaust for the pressure in the combustion chamber. The total volume of the combustion chamber must be determined by experience, this indicating a length of 5 to 10 times the diameter.

The construction of the nozzle through which the hot gases are expanded calls for notice. This should be made of a material capable of resistance to high temperatures, to chemical reactions, and to expansion and contraction stresses, besides having a fair mechanical resistance. Experience has shown that these properties are possessed fairly well by carborundum, the principal difficulty with this material being its conductivity for heat. A diverging nozzle is found to be the best, with a rectangular section, and the extremity may be made of metal, since the temperature at that point has fallen to about 800 degrees absolute, well within practical limits.

The turbine wheel itself need not differ materially from the form developed for use with steam. Single or multiple-disc wheels may be used, the arrangement being such that perimeter speeds of 150 to 200 metres per second are not exceeded. Experience has shown that temperatures of 500 to 600 degrees centigrade absolute may be used with safety, always taking care to use materials of which the tensile strength is not diminished too much at such temperatures. The best results have been obtained with a nickel-steel alloy of which the resistance is not materially affected for temperatures up to 700 degrees absolute. Nickel steel is also found to have a good resistance against the oxidizing effect of the stream of hot gases, a point of material practical value.

THE PREVENTION OF DISASTERS IN MINES.

METHODS AND APPLIANCES FOR COMBATING AND PREVENTING DISASTERS FROM FIRE AND EXPLOSIONS IN MINES.

H. Schmerber—Le Génie Civil.

IN view of the terrible disaster at the Courrières mine, attention has again been called to the necessity for providing every practicable means for preventing the occurrence of similar accidents in coal mines; or, such events having taken place, to provide the most effective appliances for meeting the great emergencies in the most effective and prompt manner. In a paper in a recent issue of *Le Génie Civil* M. H. Schmerber discusses the various kinds of accidents which may occur in mines and the best methods of preventing loss of life and for rescuing those in the pits.

Mining disasters are divided by M. Schmerber into two great classes, the first including explosions either of fire-damp or of explosive mixtures of coal dust and air, and the second covering broadly the disasters by fire, flooding, land slides and miscellaneous operative accidents. Of these the first, namely explosions of fire-damp has been the most important and disastrous in its consequences. Thus, since 1889 there have been, in Great Britain and on the Continent twelve great mining explosions from this cause, with losses of life reaching 290 in the highest to 55 in the lowest, not including the Courrières affair, of which the correct statistics are yet to be had. The list given by M. Schmerber does not profess to be complete nor to include many similar disasters, but serves to show the magnitude of the danger from this source.

Fire-damp, as is well known, is a gas disengaged in coal measures the composition being similar to methane, or marsh gas, containing about 70 to 85 per cent of pure CH_4. When mixed with air this forms very explosive mixtures, the maximum degree of explosiveness corresponding to 6 to 10 per cent of fire damp.

The formation of fire-damp cannot be controlled, although its presence may be diminished by ample ventilation, but the best preventive of disaster from this cause lies in the removal of means by which the explosive mixture can be ignited. Since the invention of the safety lamp it has generally been supposed that the danger from ignition of fire-damp by miners' lamps has been obviated, but as a matter of fact it is shown that nearly 53 per cent of the explosions, according to the statistics discussed by M. Haton de la Goupillière, have been caused, either by the exposure of the naked flame of the lamp to the gas, or by the unauthorized use of matches.

The modern safety lamp has been brought to a high degree of perfection, and the results of the trials at the official testing station at Framéries, in Belgium, reviewed in these columns in January last, show that explosions caused by the ignition of gas from mining lamps may be classed as preventable, if the best modern precautions against opening the lamps are observed, and if appliances for relighting extinguished lamps in explosive atmospheres are provided.

Miners themselves appear to have that recklessness which comes from long familiarity with danger, and unless prevented by mechanical means, they appear to be liable to open lamps, even in the very presence of the explosive gas, so that it is not sufficient to provide them with safety appliances, but this must be supplemented with every possible mechanical safeguard, which can be devised.

Next to the lamps, the mining explosives used for blasting must be considered as possible sources of gas ignition. This was a more important matter when the older forms of black blasting powder were used than at the present time, with the modern mining explosives.

Many experiments have been made in France, England, Germany, and Belgium upon the so-called permitted safety explosives for mining purposes, and there is no doubt that much has been accomplished in this direction as regards safety. M. Schmerber calls attention to some points in this respect, however, which appear to be worthy of special attention. Thus, the aim of compounders of safety explosives is to lower the temperature of the explosion below that at which any surrounding mix-

ture of gas and air will ignite. This end is usually accomplished by the employment of ammonium nitrate, sometimes in a fairly large proportion, the presence of the crystallized salt acting to lower the temperature of the explosion. This plan, however, is found to diminsh the power of the explosion and also to lower the sensitiveness of the powder to ignition to such an extent as to increase very materially the proportion of miss-fires, themselves always a profitable cause of subsequent disaster.

M. Schmerber speaks very highly of the value of the *grisoumètre,* as an indicator of the percentage of explosive gas in the atmosphere of a mine, believing that the true method of protection is the maintenance of a pure atmosphere so far as is possible.

The danger from dust explosions, once strongly questioned, has been fully demonstrated, and a number of cases are cited to show the necessity of employing preventive measures against such risks. The best plan appears to be a frequent sprinkling of the floors and walls of the mine in such a manner as to cause the dust to cake and become compacted together, thus preventing the mingling of finely divided combustible with the air of the mine. Various plans for keeping the passages clean have been proposed, but such methods usually result in the stirring up of the dust, thus only making matters worse. It does not appear that the vacuum method of dust removal has been tried for this purpose, but it might be practicable to keep the atmosphere of a mine free from dust by employing some modification of this principle.

One of the most difficult forms of disaster to contend with in a mine is fire. It is to this category that the terrible affair at the Courrières mine appears to have been originally due and it is in this connection that the question as to the possible methods of prevention and protection of fire danger demands immediate attention.

When a proper supply of water is available the usual plan is to construct light defensive barriers and to attempt to extinguish the fire by jets of water. If the fire has made material progress it is sometimes closed off by barriers, while the adjacent coal is cut away as rapidly as possible, in order to check the progress of the combustion by removing the fuel. The most general plan at the present time, however, is to shut off the burning section of the mine by strong barriers and by thus excluding the access of air, to cause the fire to smother itself with its own products of combustion. This operation, however, is surrounded with many difficulties. The high temperature produced by the combustion, and the ignition of the gases formed by the distillation of the coal, often cause the accumulation of a high pressure behind the barriers, causing dangerous outbreaks. Even if the fire is actually extinguished behind the barriers, the greatest precautions must be exercised in opening up the enclosed space, since the dissipation of the heat is very slow and the fire is very apt to break out again.

The Courrières disaster appears to have been a combination of fire and of gas explosion. Probably an enclosed fire reached an accumulated mass of gas in the older portion of the workings, and this again was followed by ignition of the dust in the air. The large amount of dust, produced by the force of the first explosion, becoming ignited, developed great volumes of carbon monoxide, in itself poisonous, while the force of the explosions completely disorganized the whole ventilation system of the mine. The destruction of the partitions by which the air was directed down one shaft and through the mine to the uptake shafts to the ventilators, caused the suction effect of the fans to act to draw the suffocating gases through all parts of the mine, and this is believed to account for a large part of the loss of life.

Apparently the only completely efficacious method of fighting fire in a mine is by the isolation and flooding of the burning section, and this can only be accomplished effectively by a previously planned system of partitions and water supply. The subject is one of the most difficult problems confronting the engineer at the present time in connection with mining operations, and may well demand the attention of the ablest members of the profession.

M. Schmerber discusses other sources of accidents and disasters in mining operations, and shows the imperative necessity for the overhauling of the internal arrangements of the older mines.

THE CONDENSATION OF STEAM.

PRACTICAL METHODS FOR IMPROVING THE EFFICIENCY OF SURFACE CONDENSERS FOR USE WITH STEAM ENGINES.

Professor R. L. Weighton—Institution of Naval Architects.

IT is not often that the professor is ahead of the practical engineer. Usually the laboratory work in engineering institutions follows the work of the commercial designer, and tests are made to determine the performance of devices which have already been put into practical use, telling the man who built them how good or how bad they are. We have, at the present time, however, an agreeable surprise in the form of a paper, presented before the Institution of Naval Architects, by Professor R. L. Weighton, discussing experiments made upon surface condensers, and showing how the efficiency of such apparatus may be immensely improved. These experiments, made in the laboratory of Armstrong College, Newcastle-on-Tyne, may well be taken as an example by the directors of similar laboratories elsewhere, showing them how the work of instruction may well be combined with that of original investigation to an extent which shall enable the builders of machinery to make improvements in their methods with the encouragement of scientific authority.

A high vacuum has always been the desire of the engine builder, and now, with the demands of the steam turbine, this is more than ever the case. But the vacuum must not cost too much, either in water or in power, or it will be purchased too dearly. Professor Weighton has shown experimentally how the quantity of water required by a surface condenser may be reduced to a minimum, and how the maximum efficiency of the cooling surface may be attained.

The engine at Armstrong College is a vertical quadruple-expansion marine engine, with attached condenser and air pump of the ordinary marine type, and for the puroses of the experiments the improved condensers were placed close to the engine and connected so that the general operative conditions could be kept as nearly as possible uniform for the different trials.

The original condenser was made with tubes ¾ inch in diameter, four feet long, the condensing water circulating twice through them giving an effective length of tube of 8 feet, the total condensing surface being 170 square feet. The new condensers were of a different type, the three condensers being similar and differing mainly in dimensions and surface. Two specific features appeared in their design, one being that the condensing water passed several times through the tubes, these being arranged in four or five groups, so that a much greater effective tube length was attained than with the old type for the same surface, while the other feature was that of provision for draining the different parts of the condenser in sections, instead of permitting the condensed steam to accumulate at the bottom. This sectional drainage was effected by dividing the interior into compartments by diaphragms somewhat inclined to the horizontal, thus directing the water formed by the operation of condensation to be drained off directly at the sides instead of permitting it to flow from the upper tubes over those beneath.

The importance of this arrangement will be seen when it is remembered that the greater part of the condensation in the ordinary condenser takes place in the upper part, where the steam impinges first upon the tubes, and this provides for drawing off the water from this portion without allowing it to flow over the lower tubes to the detriment of their action. Other features of the new type condensers are the avoidance of a large steam space at the top, providing such a passage as will just secure the distribution of the incoming steam over the tubes, together with such general internal shape as will best promote the flow of the steam over the whole tube surface.

The first of the new condensers was made with the same cooling surface as the old type, namely, 170 square feet, but it immediately appeared that, with the new design, this was much more than was necessary. A second similar condenser, with but 100

feet of cooling surface was made, and this proving of ample size for the amount of steam to be handled, a still smaller one was constructed, having tubes only 2 feet 6 inches long, through which the water circulates four times, giving an effective tube-length of 10 feet, the total cooling surface being only 62 square feet, and this was found fully equal to the work.

The results of the tests are fully given in the paper in the form of curves and in tables, to which the reader must be referred, but the general lessons of the trials may be given here as useful to designers.

So far as actual performance is concerned, the old condenser, of 18 feet cubic capacity and 170 square feet of cooling surface, maintained a vacuum of 28 inches of mercury with a consumption of 43 pounds of water per pound of steam, the rate of condensation being 10 pounds of steam per square foot per hour. The new style condenser, having 100 square feet of cooling surface, and a cubic capacity of 9.6 cubic feet, or only about one-half that of the old one, required only 24 pounds of water per pound of steam condensed, and condensed 20 pounds of steam per square foot per hour; that is, the cooling surface was twice as efficient, with a consumption of but 56 per cent the amount of water. The smaller condenser of the new type, while fully capable of handling the steam produced by the engine, took somewhat more cooling water, the consumption being 32 pounds of water per pound of steam, but the efficiency of the cooling surface was higher, the rate of condensation being 33 pounds per square foot per hour, while the space occupied by this condenser was only 6 cubic feet, or one-third that of the original one built for the engine.

The average consumption of the engine was 12 pounds of steam per horse power, and at this rate the proportion of the several condensers may be estimated. Thus the original condenser had 1.2 square foot of cooling surface per horse power, while the larger condenser of the new model had 0.6 foot, and the smaller one 0.36 foot of cooling surface per horse power, taking, as above noted 12 pounds of steam per horse power per hour.

"Surface-efficiency is at the root of all efficiency in a surface-condenser. That condenser is the most efficient in which each square foot of surface transfers in given time and conditions, as to water supply, &c., from the steam to the water, the largest number of heat units. This will, moreover, be the condenser which will not only register the highest vacuum, but will maintain it at the least cost in condensing water, and with the smallest surface and cubical capacity per pound of steam condensed. It will also, in given conditions, be the one to yield the highest hot-well temperature. Now, in order that a surface may thus act, it is necessary that the steam should have free access to, and should pass over, sufficient surface on the one side, and that all the condensing water should come into direct and efficient contact with the surface on the other side. This clearly cannot be the case if on the steam side practically the whole surface is continually subjected to showers from the water of condensation, or if the steam can short-circuit any material amount of the surface; nor can it be the case on the water side if the condensing water flows through the tubes in unbroken cylindrical streams, the peripheries of which streams alone come into actual contact with the tube surface, and a greater or less proportion of water-core passes through without efficient contact. Hence the augmented efficiency of the surface as a whole, due to the early interception and removal of the feed-water, the provision for promoting steam circulation, and the adoption of a suitable ratio between the surface and the water-carrying section of each tube element."

In order to bring the cooling water into intimate contact with the surface of the tubes Professor Weighton introduced into each condenser tube a core of wood of triangular section this forcing the water to the inner surfaces of the tubes and preventing the flow of a core of idle water through the centre. It is thus seen that the new condensers were designed with the special object in view of attaining the highest surface efficiency, and the greater this efficiency the less the quantity of condensing water required per pound of steam condensed.

"Economy of water is important from several points of view. First, as in the case of land installations, water may itself have to be purchased. Second, it has to be

pumped through the condenser; and any saving in water means, other things being equal, power economy in vacuum production. Third, water may have to be cooled for repeated use, and in this case surface-efficiency of condenser has a double effect. Not only is there less water to be pumped, but owing to its higher outlet temperature there will be a greater mean difference between the temperature of the water to be cooled and the air which cools it; and hence cooling towers will be more efficient, and may therefore be of smaller size for given power.

Another important result of enhanced surface-efficiency is, of course, economy of condensing surface. Owing to steam space being dispensed with in the new type, a given surface is contained in less capacity of condenser-shell. These two features conduce to economy of weight and capacity. From the point of view, therefore, of weight and space occupied, the new type of condenser has important advantages, which would seem to render it peculiarly adapted for use on board ship, and specially so for all classes of war vessels, in which both weight and space are of supreme importance."

In connection with these condenser tests, these involving some four hundred carefully conducted trials, the subject of air-pump efficiency and proportions was considered, various types of air pumps being tried. In general it appeared that, when the system and piping is fairly tight, a pump capacity of 0.7 cubic foot per pound of steam condensed is as good as anything larger, but when air leakage exceeds a certain amount, larger pump capacities are necessary for the maintenance of the required vacuum. No apparent advantage appeared from the use of compound air pumps.

In general the following conclusions appear to follow from the experiments, as applicable to the design of condensers of maximum efficiency.

"1. It is conducive to efficiency in a surface condenser that the water resulting from condensation should be intercepted and removed from the condenser as soon as possible after it is formed.

"2. It is conducive to efficiency that the condenser capacity should be a minimum consistent with the accommodation of the necessary surface, and that the design should be such as to secure a pervading and uniform flow of vapour throughout the condenser section, thus utilizing the whole of the condensing surface provided, as well as obviating stagnant recesses in which air might be retained.

"3. It is conducive to efficiency that the condensing water should travel at a fairly high speed through the tubes, and that it should enter at the bottom and leave at the top of the condenser.

"4. With suitable condenser design and proportions, the temperature of the condensing water at the discharge point may be equal to, or slightly higher than, the temperature due to the vacuum. This holds true for vacua up to slightly over 29 inches.

"5. With suitable condenser design and proportions, the temperature of the hot-well may be from 3 degrees to 5 degrees higher than the temperature due to the vacuum. This holds true for vacua up to slightly over 29 inches.

"6. With suitable condenser arrangements and a reasonably air-tight system, there is nothing gained in efficiency by the use of air-pumps exceeding in capacity 0.7 of a cubic foot per pound of steam condensed, up to a limit of close upon 29-inch vacuum. For vacua exceeding this limit, or for cases in which air-leakage is considerable, the air-pump capacity must be increased, or else the vacuum-efficiency will fall.

"7. With suitable condenser design and proportions, and in conjunction with dry air pumps, a condensation rate of at least 20 pounds of steam per square foot of surface per hour will be maintained in association with a vacuum of 28½ inches, and a quantity of condensing water equal to 24 times the feed water, at an inlet temperature of 50 degrees.

"8. With suitable condenser design and proportions, and in conjunction with dry air pumps, a condensation rate of at least 36 pounds of steam per square foot of surface per hour will be maintained in association with a vacuum of 28½ inches, and a quantity of condensing water equal to 28 times the feed water, at an inlet temperature of 50 degrees.

BRITISH COAL RESOURCES.

THE PRACTICAL PRINCIPLES INVOLVED IN COAL CONSERVATION, POWER TRANSMISSION, AND SMOKE PREVENTION IN GREAT BRITAIN.

Arthur J. Martin—Society of Arts.

ABOUTa year ago we reviewed in these colun.ns the report of the Royal Commission appointed to investigate the important question of the nature and probable duration of the coal supplies of Great Britain, this report indicating that at the present rate of working the existing available coal resources should provide for the requirements of the next 200 years; this taking the limit of practical working depth at 4,000 feet. We now have an interesting paper, presented before the Society of Arts by Mr. Arthur J. Martin, emphasising the supreme importance of husbanding the coal resources of the United Kingdom, and discussing some of the most important examples of waste, with their remedies.

Mr. Martin calls attention to the fact that the supply of coal will naturally not be cut off short at any definite period, but that in consequence of the increasing cost of production the price will gradually rise until it is found that imported coal can compete with the home product, much in the same manner as the source of grain supply has gradually been transferred, during the past century, from the agricultural districts of Great Britain to the imports from abroad. At the present time England is dependent upon foreign supplies for about two-thirds of her food supply, and as the countries from which these supplies are drawn are filled up these sources will become restricted. The same may be expected in connection with the coal supply as soon as the increasing depth and cost of mining renders competition possible.

The principal burden of Mr. Martin's paper is that this evil day may be long postponed by the prevention of a large portion of the present enormous wastes accompanying the consumption of coal for industrial and for household purposes.

"Whether the impending coal famine sets in 20 years hence or 200, it is not a thing to which we can look forward with satisfaction; and the historian of the year 2100 is not likely to form a favorable judgment of the ancestors to whose extravagance his own generation owes its deprivation of one of the prime necessaries of life.

"Looking at the matter from its ethical side, it may well be questioned what right we, as mere tenants for life and trustees for the generations to come, have to squander their share, as well as our own, of an inheritance which has taken untold ages to accumulate, and which, once lost, can never be replaced. If any question of the kind is raised, it is apt to be met by glib talk of some new discovery, such as the utilisation of radium, or of the solar rays, whereby we shall be enabled to dispense with coal.

"The Commissioners devote some space to a consideration of the possibility of finding an alternative source of energy, and come to the following conclusion, 'we are convinced that coal is our only reliable source of power and that there is no real substitute. There are, however, some possible sources of power which may slightly relieve the demand for coal.'"

The fuel consumption in Great Britain may be divided into three parts: that used for power production, estimated at about one-half the total; that consumed in industrial operations other than power, using three-tenths; and that used for domestic purposes, taking one-fifth.

Mr. Martin shows in a popular way, by means of diagrams what the engineer also knows by experience, that the most economically designed steam boilers and engines succeed in utilizing only about 14 per cent of the energy in the coal consumed; this partly because of the lack of efficiency of the mechanism, but largely because of the thermo dynamic principles involved in the conversion. This efficiency, however, is by no means attained by the majority of engines and boilers, and it is probably safe to say that instead of consuming between one and two pounds of coal per horse-power, the average consumption of steam engines in Great Britain is five pounds per horse-

power-hour; while small, and neglected engines use as high as 30 pounds and more. There is here a means of saving at least one-half of the coal consumed in power generation, or one-fourth of the total consumption in Great Britain, simply by using good for bad engines.. If gas engines were substituted for steam power, it would be easy to secure a better economy with small engines than is now possible even with the best and largest steam engines, and a consumption of one pound of coal per horse-power-hour might become average practice.

In industrial operations and in domestic service it is easily apparent that fully double the amount of coal is consumed than is necessary to obtain the amount of heat required, and for these purposes also a corresponding economy would be secured by the use of gaseous, instead of solid fuel. The great benefit arising from the entire abatement of smoke production consequent upon the abadonment of solid fuel should also be considered, and this phase of the question was fully discussed by Mr. Martin in this paper presented before the Royal Sanitary Institute, and reviewed in these columns in March last.

All considerations, then, point to the desirability of substituting gaseous for solid fuel, and this point once conceded the full measure of its possibilities begins to appear. Instead of conveying the coal, at much expense for transport, to the vicinity of the large cities, the possibility of producing fuel gas at, or near the collieries at once suggests itself. Oil is conveyed many hundreds of miles through pipe lines, and in the natural-gas districts of the United States gas is delivered to great distances under high pressures. There is, however, an additional advantage, suggested by Mr. Martin, which demands thoughtful consideration. The transmission of power by compressed air is an operation well-known and successfully conducted. In mining operations, tunneling, etc., compressed-air transmission is a standard method of operation. In Paris the power-distribution service of the compressed air company is an old established business.

"From power transmission by compressed air it is but a short step to the conveyance of gas under pressure for the same purpose. The mode of transmission is the same in both cases; but as regards the medium employed the advantages of gas over air are overwhelming. Working at a pressure of six atmospheres, as in Paris, a good motor requires some 550 cubic feet of air per indicated horse-power per hour; in a gas-engine 14 1-3 cubic feet of ordinary lighting-gas will do the same work. The specific gravity of lighting-gas being only four-tenths (taking air as unity), the volumes of the two fluids carried by the same main will be in the proportion of 16 to 10, if the initial and terminal pressures respectively are the same in both instances. This, however, would not be the case, for, whereas with air a small part only of the initial pressure is employed for transmission purposes, every pound of pressure consumed in this way being so much less available for working the motors, in dealing with gas the whole power of the compressors may be used to force the gas through the pipes, the power to be realised at the receiving end depending, not merely on the pressure of the gas as received, but chiefly on its calorific value. By reason of these various advantages, a main and compressor-plant dealing with gas will transmit no less than 150 times as much power as could be sent by means of air. Add to this the fact that the use of compressed air is practically limited to the production of power, whereas gas serves also as a source of light and heat, and it will be seen that the commercial possibilities of compressed air, great as they are, dwindle into insignificance beside those of gas."

Mr. Martin goes at length into the details of the cost of generating and compressing the gas at the mines, and the problem of using it, first, to transmit power directly, by means of compressed-air motors, and secondly, by supplying a smokeless fuel, of maximum efficiency, either for power generation or heating. The general result of his computations is to show that such a gas might be delivered into the gas-holders for a cost of about 7d. per thousand cubic feet, and sold to the consumer for about one shilling.

"Turning now to the incidental consequences of gas transmission, and giving due preference to the fog question, the general supercession of coal by gas would put an

end, once for all, to the smoke nuisance, and the abnormal blackness and persistence of the London fog would become a memory of the past. Although for the sake of definiteness, I have hitherto dealt with the matter solely in its relation to London, there is no reason why gas should not be piped in the same way to every city and town in the kingdom. To inland towns indeed, which pay 18s. or 19s. for their gas coal, cheap gas would be an even greater boon than to London, with its sea-borne supply. Nor need the benefits of cheap gas be confined to the towns, for there is no reason why the trunk mains should not be tapped at any desired point along the route. The cause of industrial decentralisation could be given no greater stimulus than it would receive from the provision of light, heat and power at a minimum cost along every foot of the pipe-lines from the collieries to the metropolis.

ECONOMICAL GENERATION OF POWER.

A COMPARISON OF THE HIGH EFFICIENCY OF GAS POWER WITH OTHER SOURCES OF MECHANICAL ENERGY.

E. R. Knowles—Electrical Review.

NEARLY a hundred years ago the work of the engineer was defined as consisting in the direction of the great sources of power in Nature to the use and convenience of man, and only a short time before his death the late George S. Morison expressed himself as of the belief that the great work of the engineer consisted in the manufacture of power.

In a paper published in a recent issue of the *Electrical Review* Mr. E. R. Knowles reviews the growth of the internal-combustion motor, and under the title of the "coming power" he shows that in many instances it is more economical to employ the gas engine than it is to harness the apparently cheaper power of the natural waterfall.

Steam power, as may readily be shown, suffers in efficiency by reason of the imperfect thermodynamic cycles to which we are limited in its use; besides which the successive transformations leave opportunities for losses which are fatal to the accomplishment of the highest results.

"The reason for the enormous loss lies in the large number of transformations and apparatus which the thermal units have to pass through before the desired result is obtained, and in the system itself, which is inherently inefficient. The combustion in the furnace, the radiations from the boiler, piping, auxiliary apparatus and engine, the waste gases in the chimney, the waste steam in the exhaust, the condenser and other auxiliaries all claim their quota, and so large a one that very little is left for useful effect. The truth is that the source of power is, so to speak, too far removed from the point of application.

"The nearer to the point of application the fuel can be utilized and the greater the number of these intermediate transformations that can be eliminated, the less will be the losses, and consequently the greater will be the useful effect.

"In order to accomplish this desired result the effort has been made, and quite successfully, to burn the fuel directly at or in the engine and thus eliminate all of the intermediate steps and utilize to the utmost the full value of the thermal units in the fuel."

The use of the gas engine does not mean that the manufacturer is obliged to depend upon outside sources for the gaseous fuel for the engine upon which he relies for his power. On the contrary, it can be shown that it is easier, cheaper, and more convenient for him to manufacture his own power gas than for him to generate steam in a boiler for use in an engine of one-half the efficiency. This fact being accepted, the real advantages of the power-gas plant remain to be fully understood, and Mr. Knowles sets forth these advantages in a most convincing manner.

"In the first place the gas engine producer system is universally adaptable because it can utilize any form of fuel material; it can be installed at any point where fuel material and water can be obtained, and it is not dependent on any form of manufactured commodity for its maintenance and operation.

"Next it is cheapest because the initial cost of the installation is low; the cost of building room or floor space occupied is a minimum; only a small fuel storage is required; a small amount of water is needed, and this water can be used over and over again; the lowest grades of fuel materials can be employed, and the thermal value of the fuel material utilized to the utmost; the fuel can be burned exactly at the point of power generation, and a very large proportion of the thermal losses due to transformations be prevented; the cost of maintenance and repairs is reduced to a minimum and the stand-by losses are low.

"Then the producer gas system is simple and compact because the apparatus is self-contained, the space occupied is small, the erection and arrangement of the system is not complicated and there are few parts, no chimney or high-pressure steam boilers are necessary, the piping system is simple and little auxiliary apparatus is required.

"The system is efficient also because of the uniform quality of the fuel used; no fuel is wasted; the fuel is consumed in proportion to the load; perfect combustion of the fuel is attained at the point of power production; a very high per cent of the thermal units in the fuel is utilized in the production of power; the same thermal efficiency can be had in small as in large installations; fuel storage in the most compact and valuable form can be had without any loss of energy in the fuel stored, and the thermal losses in transmission in the system are reduced to a minimum.

"It is safe because there is no high-pressure steam boiler required, no high pressure in the piping, no danger from fire or explosion, it can be started and stopped instantly and there is perfect and automatic control of the system.

"It is sanitary because no smoke or deleterious vapors are given off, and the installation is clean, unobtrusive and not a nuisance in the neighborhood.

"Its repairs and maintenance are low because the installation is simple and has few parts; there is no high pressure in the system and no leaky joints, valves, etc., to be made good; the standby losses and wear and tear are reduced to a minimum; no licensed engineer or firemen are required, and no skilled labor is necessary.

"The attendance and attention required is small because the fuel and ash is centralized, all being handled at one point; the installation is always ready to operate, is automatic in operation; there are no delays for cleaning or starting fires or getting up steam, and the system can be operated continuously on long runs without injury, breakdown or adjustment."

Even where hydraulic power is available, Mr. Knowles shows that gas power can compete with it successfully. In a tabulated statement of the costs of power from various sources it appears that gas power ranges from $16 to $13 per horse-power per year, when producer or natural gas is used; while steam power costs about $40 and hydraulic power $29 per year per horse-power. In nearly every case the development of a hydro-electric plant involves the investment of a large amount of capital and the interest charges on the investment on the plant render water power more expensive in most cases than gas power, all other things being equal.

It is not claimed that gas power is free from losses, but it can be shown that the losses in a producer gas plant, and the heavy interest charges of a fully developed hydraulic power plant, when fairly compared, will show a large margin in favor of the combustion engine as a source of motive power.

"Doubtless, as time passes, still further improvements will be made in the gas system, and means will be found whereby the large percentage of waste, which still exists in this system, may be utilized for heating purposes and this objection finally removed.

"Finally, while the gas engine producer system is still far from the desired ideal system, nevertheless the great gains in efficiency of lowering the cost production shown by this system and its many advantages are such that with its advent the gas engine has made such rapid strides as a prime mover, and its adoption to power generation has given so much satisfaction not only from an economical point of view, but also for continuous and hard service, that it bids fair to revolutionize all present methods of power production and to become the legitimate successor of the steam engine and steam system."

RAILWAY EDUCATION.

POSSIBILITIES IN THE APPLICATION OF COLLEGE METHODS TO THE TRAINING OF RAILWAY EMPLOYEES.

Professor E. R. Dewsnup, St. Louis Railway Club.

TECHNICAL and scientific training has been provided in nearly all modern colleges for various departments of applied science, but there appears to be a demand for a still higher degree of specialization than has yet been attained. In a paper read before the St. Louis Railway Club, Professor E. R. Dewsnup, of the University of Chicago, discussed the desirability of providing a college for instruction in the different departments of railroad work, as distinguished from the engineering operations for which provision is already made in the regular engineering courses of many existing institutions.

"The number of persons engaged in engineering, in architecture, or in educational work falls far below the number at work in the transportation industry, and yet there has been but little effort to provide technical training for the latter. As a part result of this the railways are finding themselves today in lack of a sufficient number of men qualified to occupy, with dignity and with success, the positions of initial responsibility; men who know how to do the right thing at the right time, who show initiative and originality when thrown back upon their own resources, who possess not merely physical or brute obstinacy but especially that inflexible mental determination and persistency arising from the realization of the trained mind as to the relation of the individual worker to the collective working. It may be that careful professional training will be of considerable benefit to those destined to attain to the seats of power in the transportation industry; I am inclined to think that it will. The conducting of modern transportation is becoming constantly more and more complex; the day of happy-go-lucky, rule of thumb railroading, while not entirely gone, will soon be but a shadow of the past. There is no industry at the moment which demands keener intellect, shrewder wit, and better trained comprehension; no industry in which the failure of these qualities in its officers and, to no small extent, in its men, would be more disastrous to the general interests of the country. The necessity for, and demand for, an adequate supply of these qualities is increasing with the extension of the industry. In sheer self-defense, even from a dividend point of view, the railways of this country will have to pay more attention than they have ever done before to the improvement of the quality of the men they take into their employment. For their own interests, they must stimulate a steady flow of the brightest minds of each rising generation into their service, so that they may have ample choice of selection in filling up the lieutenancies and corporalships, some of those appointed to which, in turn, will qualify for responsibility as captains and colonels, and, maybe, even as generals of the railway army. There are all varieties of transportation problems, but, without doubt, the most difficult one of all is that of securing competent and trustworthy service."

The railway problems demanding special training relate to two departments of work, the first covering a regular course in transportation problems, bearing the same relation to the profession of railroading as the law school or the medical college does to the profession to which it relates. This branch relates to the provision of new men for the coming work of the railroads. There are, however, a great number of men already in service for whom technical education should be provided, and this naturally requires a different treatment.

"The railway companies, as a first and great step, should co-operate in founding, in some great railroad center such as Chicago, a railway college. The task of establishing the college should not be left to the railways centering in Chicago. The companies of the north, east, south and west will secure no less benefit from the realization of the project than the first named. I believe that the college should be placed in acadamic relation with the University of Chicago, because the broadening influence of a great university would be a good thing to have environing its students.

"One distinctive feature of this college should be the arrangement of the work of its members. The students should follow their classes from the beginning of October until the middle of June, and from that time until the middle of September should be placed out on the railroads at a small salary to learn the practical details of the business. They could be used to fill in the odd vacancies (which occur during every part of the year), and, even if they did not accomplish much, they would probably earn the small salary assigned. The combination, in each year of college life, of the theory of the class with the practice of the road would be beneficial both mentally and morally to the student. Any inclination to the swelled head acquired in the class room, would be knocked out of him most effectually by his associates in employment. During the whole period of the three months, he would be required to submit weekly reports as to the work he was doing.

The question of admission requirements is discussed by Professor Dewsnup, and he advocates the inclusion of a suitable preparatory course in the various high schools, this preparatory training covering the broad general foundation upon which the special course in railroading may be effectively reared.

"The courses of the railway college should provide training on five different sides, mechanical engineering, civil engineering, electrical engineering, commercial and operating, all with distinct reference, of course, to railroad work. To effect this the college should be in close touch with the engineering department of the university, so that courses common to railroad and general engineering should not need to be handled in the railway college, only those courses coming under its direct charge which bear a distinctly railroad aspect—for instance railway construction, maintenance of way, locomotive construction, locomotive tests and so forth."

Naturally the development of such a college as that suggested by Professor Dewsnup would make heavy demands for its financial support, but its value to the railways would be so great that such support ought to be forthcoming readily, both in the form of equipment and endowment.

"A difficulty of more importance than the financial one, though still but temporary, is that of securing suitable instructors. We need men of the highest and broadest mental training, keen in investigation, sympathetic in teaching, men who possess the most desirable academic qualities and qualifications, and at the same time have the practical instinct. We see no other opportunity but to train our own instructors and this we are proposing to do by taking able university graduates of suitable preparation, placing them for twelve months or so out on the road, a month here, three months there and so on, engaging in the practical side of the subjects in which they are specializing, studying the different methods in use and their relative values, consulting with and being advised by railway men of all grades and opinions. Furthermore, not only will they do this before engaging in teaching, but as instructors of the college, they will be expected to keep in touch with movements, in their respective departments, on the railways.

"It has been suggested that the railway college should be largely staffed by railway men. Where suitable men of actual road or office experience, efficient teachers and capable of real research work, in short, likely to do credit to the college, could be obtained, such could be made good use of. But the ex-railway man who has "resigned" because of incapacity, we do not want; the ex-railway man who has been worked out, we do not want; the ex-railway man who is looking for a kind of retiring allowance in the shape of a nice easy job, we do not want. The railway man of trained mind, high capacity and wide experience, possessing undoubted powers of discipline and exposition, associated with a strong personality, we do want, but we could not get him for the railways need this type of man for their own service, and are able to pay him anywhere from three to ten times as much salary as we could give him. A careful study of the question has convinced me that the policy of training our own instructors, securing them before they have the opportunity of making high salaries, men who combine the practical instinct with power of exposition, who possess love for research and are disposed toward teaching, is not merely the only feasible plan, but, except in special instances, the most desirable one."

GAS ENGINES FOR SHIP PROPULSION.

SPECIAL PROBLEMS IN PRODUCER AND ENGINE DESIGN TO ADAPT THE INTERNAL-COMBUSTION MOTOR TO MARINE SERVICE.

J. E. Thornycroft—Institution of Naval Architecture.

IN view of the high efficiency which has been attained by internal combustion motors for stationary service it was to be expected that gas engines should be applied to marine propulsion, and we have recorded from time to time in these columns the efforts which have been made to accomplish this desirable end. A very complete review of what has been done in this direction is given in a paper presented before the recent meeting of the Institution of Naval Architects by Mr. J. E. Thornycroft, and some abstract of this paper will serve to show the nature and extent of the difficulties which have been encountered and which are being overcome in this department of marine engineering.

Mr. Thornycroft calls attention to the fact that conditions afloat are very different from those obtaining in a land plant, and in order to make these differences clear he discusses some of the general features of such gas-power plants as have been found practicable on shipboard.

"The majority of small gas engines work on the 'Otto' cycle, which has the advantage of requiring no special gas or air pumps, and this is the only type of engine that has been as yet tried for marine work. The gas producer which is generally used for moderate powers works on what is known as the suction principle; that is to say, instead of the gas being generated by the combustion of fuel, by air and steam being forced through it under pressure, it is generated by the air being drawn through the producer, the whole of the apparatus working somewhat below atmospheric pressure. The advantage of this system is that neither a steam boiler working under pressure, nor a gas container for holding the gas is required, and the further very important advantage for marine work is that there is no danger from a leakage of gas from the producer; if leakage takes place, it is from the atmosphere into the producer itself.

"There are so many combined plants consisting of a gas engine working in conjunction with a suction producer at work for stationary purposes, that it might appear only very small alterations would be required in these plants to adapt them for marine propulsion; but, in addition to the great difference between almost all marine and land plants, viz., that of the quick and frequent variations of load which the smaller types of marine plants have to undergo, there are very many features which must be changed to adapt the gas engines and producer to boat work. In fact, it will be found that the principle of operation will be about the only thing which can be identical with the land plant, the details of the apparatus all having to be specially worked out for the new conditions. The producers for moderate-sized powers are usually worked with anthracite coal, and where vessels are to be used on fixed routes, and the same class of fuel can always be obtained, anthracite or coke will be found to be the most suitable for moderate powers, it being too difficult to make a satisfactory small plant to work with bituminous coal. For larger powers, and for vessels that have to take up fuel at different ports, the producer must be capable of dealing with coal, other than anthracite, which may be of a tarry or caking character.

"The design of the producer capable of successfully dealing with bituminous or caking coal is a much more difficult problem than the anthracite producer. There are, of course, very many large land installations of pressure producers working with bituminous coal, but the apparatus for extracting the tar and other by-products, as at present arranged, is far too cumbrous for marine work, and the marine producer to deal with this class of coal must be designed on entirely different lines, being arranged to consume the tar which is evaporated off from the coal in the first stages of its heating. This has been arranged in some producers by taking the gas off at a comparatively hot part of the fire, instead of at near the top of the new coal, as is

usually the case with the anthracite producer; but there are plants now at work dealing successfully with bituminous caking coal, which are fed by an undertype stoker, so that the new coal is forced into the hottest part of the fire, and the tar which is driven out is at once burned. After the gas leaves the producer, it must be first cooled, and, as there will always be a certain amount of impurity, even when anthracite is used, it has to be thoroughly cleaned. This is usually done by passing the gas through a series of vessels where it is scrubbed by its passage through layers of coke over which water is running. It is frequently arranged that the cooling of the gas is effected by passing it over a water-containing vessel, which acts as a generator for the steam required by the producer; but there are disadvantages in this method where the producer is not working at a uniform load, as the steam will not be generated until the producer has been working some time, and will continue when the engine has been stopped, and when it is not required, and so cool the fire, causing the gas to be poor when the engine is again started, after the temporary stoppage has taken place. The large space occupied by the ordinary coke scrubbers prohibits their use for marine work, and to meet this difficulty Herr Capitaine has arranged his plant to clean the gas after it has been cooled by the introduction of a very fine spray of water, which mixes with the small particles of dust and other impurities in the gas, and forms a sort of fog; the gas in this stage is passed into a centrifugal apparatus having a peripheral speed of 160 feet a second, which throws out the moisture and impurities, leaving a clean dry gas to be drawn out by the engine."

The gas furnished by the suction producer is what may be termed a lean water-gas, consisting of about 25 per cent of carbon monoxid and 12 to 15 per cent of hydrogen, the balance being non-combustible, and since the combustion of the fuel is but partially effected in the producer, the principal combustion taking place in the engine itself, the producer occupies a very small space compared with the boilers for engines of equal power.

The advantages of the suction producer gas plant in stationary installations being fully conceded, the important thing in connection with its application to marine purposes is to consider the practical difficulties inherent in its operation afloat.

"The one great disadvantage of the internal combustion engine is the necessity of setting the engine in motion before it will run automatically. For powers less than 200 horse-power, it is preferable to employ a reversing gear, keeping the engine always running in the same direction, or to use a reversing propeller. Compressed air is being employed for starting up large engines, and when once the engine is fitted in this way, the valve gear for running the engine in either direction does not amount to very much. For moderate powers, a single-acting engine with a trunk piston is found most convenient, as the piston does not require to be water-cooled, until one as much as about 2 feet in diameter is employed. A single cylinder of 20 inches diameter and 2 feet stroke, running at 120 revolutions per minute, will give about 100 horse-power, taking the average working pressure at about 80, which is less than the figure often obtained. The same sized cylinder, working as a double-acting cylinder, would, of course, double the horse-power; but, besides the additional valves, which must be an exact duplicate of those required for a single-acting engine, there is the complication of the water-cooled piston and rod. This at first sight will appear somewhat serious to the marine engineer; but when the very large number of engines of this design which are working on land are considered—the regularity with which they are run, and the little attention they require—it will be agreed that there does not seem any reason why they should not meet with success at sea. For small plants of from 100 to 200 horse-power, a small auxiliary internal combustion motor, driven by oil or some other fuel, is found most convenient for blowing up the producer, for starting it, and also for starting the main engine. For larger powers fitted to vessels where steam capstans and steering gear are fitted, it is thought that the best plan will be to employ an auxiliary boiler, which can be heated by the gas when the whole plant is at work, and can be used independently to drive the various auxiliary and starting engines when the producer is not alight."

Mr. Thornycroft gives in his paper a number of illustrations of details which have been introduced by Herr Capitaine in his practical experiments, and some of the accounts of actual performance show that the adaptation of the gas engine to marine propulsion has become an accomplished fact.. The early experiments were made with a small boat of 16 tons displacement, but with this small craft a run of ten hours was made at a speed of 10 knots, with a total fuel consumption of 412 pounds of anthracite. Later trials were made on a larger boat from Hamburg to Kiel and back, this boat being 44 feet 3 inches long by 10 feet 6 inches beam, with four-cylinder motor of 70 horse-power. For purposes of fuel comparison the gas propelled boat was accompanied by a steamboat, the Elfriede, of practically the same dimensions and powering. The results showed that the gas-propelled boat required 530 pounds of anthracite, while the steamer consumed 1,820 pounds of steam coal, an advantage of 1 to 3.44 in favor of the gas plant. Both boats made a speed of 8½ knots, and the results may be accepted as comparable.

On the Rhine there is running a barge of 200 tons displacement operated by a two-cylinder Deutz gas engine and producer, giving satisfactory service between Rotterdam and Cologne, while in England a trip has been made with a barge equipped with a two-cylinder Capitaine gas power plant through the English canals.

The general results of these experiments have been so encouraging that engines of 500 to 1,000 horse-power are now being constructed by Messrs. Beardmore & Co., and we may soon expect to see such machines installed in large sea-going vessels, to the great improvement in fuel consumption, as well as increase in available cargo space. Comparative plans for steam and gas power plants in a cargo steamer of 7,000 tons displacement show that with the gas power plant there is a gain of 13,000 cubic feet of cargo space.

THE MOTOR OMNIBUS IN LONDON.

A DISCUSSION OF THE RELATIVE FIELDS OF THE SELF-PROPELLED OMNIBUS AND THE ELECTRIC TRAMWAY.

E. Manville—Automobile Club.

IT is generally conceded that in most great cities the horse-drawn vehicle must be generally supplanted by some form of mechanically propelled apparatus. In the great cities of Europe, and especially in London, the omnibus has held the field so long and so successfully, that when any change appeared necessary it was most natural that it should take the form of the new power applied to the old vehicle. In the United States, however, the omnibus was long ago supplanted by the horse-drawn tram-car, and this in turn was succeeded by the cable traction system and then by the electric trolley car, so that the two systems have grown up, not exactly side by side, but at least contemporaneously. There has now arisen, in London some difference of opinion as to whether the motor-omnibus is the thing, or whether, in abandoning the horse, the change should not have been made directly to the electric tramway system. In a paper presented recently before the Automobile Club by Mr. E. Manville the relative advantages of both systems are set forth, and we make some abstracts from this discussion, setting forth both sides of the question.

Mr. Manville sums up the advantages and disadvantages of both systems with an evident desire to be impartial, his opinions being as follows:

For the motor-omnibus, there is a probable greater speed from point to point, owing to the freedom of movement upon the road, the ability to vary the route from one road to another, the capacity to draw up by the pavement for passengers, the freedom from rails in the road, and the non-interference with other vehicles. Its disadvantages are its high cost of operation, its noise, smell, vibration, and general danger to other vehicles, together with its unreliability.

The electric tramway, on the other hand, has the lowest known cost of operation, comfort, cleanliness, and good lighting, together with reliability, and absence from

danger. Its disadvantages, on the contrary, lie in the fact that it is confined to its rails, compelling passengers to cross to the middle of the road to enter or leave the cars, and the obstruction which it offers to other vehicles in narrow streets and roads.

"It cannot be denied that, amongst the disadvantages of the motor 'bus, there are some which are of the very first importance. I refer particularly to such items as the danger of side slip, the prevalence of which is so well known that it requires no further comment from me; danger of fire is one that has already asserted itself on several occasions, and though so far it has not led to serious accidents, as in the case of side-slip, it obviously may do so, owing to the necessity of carrying about large quantities of highly inflammable motor spirit. The first of these serious disadvantages is entirely absent from the electric tramcar, and the second one, although not entirely absent, cannot, on the rare instances when it occurs, lead to anything in the shape of danger to the public. It cannot, on the other hand, be denied but that the tramcar, when run in very narrow roads, leads to obstruction of other vehicles wishing to stop by the roadside; also the tramcars themselves having to keep to fixed lines, are delayed by other traffic interfering with their progression. As counterbalancing the installation of rails in the roadway may be mentioned the great improvement in the paving of many roads along which tramways run. It is common knowledge to all of us that the roads leading out from the metropolis and from other cities and towns in the kingdom have been kept in a most disreputable state of repair, owing to the inability of the local authorities to spend a sufficient sum on their unkeep outside of the centers. The principle which has been instituted in enforcing good paving for a portion of a road, as a penalty to be paid for the installation of the tramway system, has very largely benefited other users of the road in this direction, and it must be recollected that the tramway itself derives no advantage from the paving which it has to instal and maintain, the benefit of which accrues entirely to the other users of the road.

"Reviewing then, impartially the statements set forth above, I think it must be conceded that the balance of advantages, both to the traveling and non-traveling public, pertain to the tramway system rather than to the motor 'buses.

"If motor 'buses are started in competition with tramways already existing, or if tramways are started under suitable conditions in towns where motor 'buses already exist, it is certain that the motor 'bus, if worked will cease to exist."

So far as the relative costs of the two systems are concerned, Mr. Manville makes up two balance sheets, one taken from the operations of the Leicester Corporation Tramways, and the other from estimates especially prepared from data on the operation of motor omnibuses in London. The tramway sheet shows that the average receipt per car mile was 7.866d, and the total cost of operation, repairs and maintenance 4.583d.

In the case of the motor-omnibus system, the costs per car mile work out as high as 10.51d, while the income shows only 7.842d, or a net loss of nearly 30 per cent.

"From this it is evident that such a system run by motor omnibuses under prevailing conditions could only be a financial failure, but it must be borne in mind, whatever the academical opinions of promoters of motor omnibus enterprises may be, that it is almost certain no extensive system of such vehicles would be permitted within a town without heavy contributions in some form or other towards the paving of the streets, and, in that case, still further capital and renewal charges would have to be made.

"These two comparative balance-sheets take us a step further, since they enable me to construct a curve showing where, from the financial point of view, the costs of motor omnibus traction and of electric tramway traction become equal, and, following it on, where motor 'bus traction becomes more economical than electric tramway traction.

"The amount invested in the permanent way and overhead equipment of an electric tramway system is practically constant per mile, whatever the service of cars might be upon it, and, therefore, the interest on this portion of the capital must be divided amongst the car-miles run, whatever they

may be, so that the smaller the service the greater the burden of these capital charges.

"In every city or town in which electric tramways exist there are numbers of routes in which the service that could be profitably maintained is less than that shown upon the diagram, and electrical tramway undertakings are beginning to use, and doubtless will exhibit an increasing tendency to use, motor 'buses.

"In all the smaller towns where the minimum profitable tramway service cannot be maintained, motor omnibuses will have the entire field to themselves. So also will be the case in those numerous instances where towns not directly lying upon the railways require communication with these.

"Of the crowded centers of population London offers a unique field for the use of the motor 'bus. There the tramway system must be carried on under disadvantageous circumstances: First, because it cannot reach the centers of the City, and, therefore, provide through communication; secondly, since overhead wires are not permitted, vastly increased capital costs are experienced in the construction of the electric tramways system.

"On the other hand, the vitality of the electric tramway system in London is well shown, since, although it is handicapped so materially by not being able to reach the center of the city, it nevertheless carries enormous numbers of the public, and has proved itself a most comfortable, profitable and convenient method of traveling."

PROBLEMS OF HIGHWAY MAINTENANCE.

METHODS OF DRAINING EARTH ROADS IN THE PRAIRIE SOIL OF THE MIDDLE WESTERN UNITED STATES.

Ira O. Baker—Engineering Record.

WITH the growing interest in the construction of good roads in the United States everything which relates to the maintenance and improvement of highways demands attention, and hence the bulletin upon the drainage of earth roads, issued by Professor Ira O. Baker, of the University of Illinois, and published in a recent issue of the *Engineering Record* forms a subject for comment and review.

Of course the great highways constructed by the best engineering ability, and maintained by sufficient expenditure have includen in their design such suitable drainage systems as may be indicated by local conditions. In the middle western states, however, there are many earth roads, built at moderate expense, in prairie soil, which need only proper drainage to remove much of the disability under which they labor, especially in the thawing periods after the winter freezing temperature. It is to this department of road work that the bulletin of Professor Baker is directed, although much of its matter will be found valuable and appropriate for use elsewhere.

"The best and cheapest method of securing underdrainage is to lay a line of porous or farm tile 3 or 4 ft. deep on one or both sides of the roadway. It should be uniformly burned, straight, round in cross-section, smooth inside and have the ends cut off square. Before the introduction of tile for agricultural drainage, it was customary to secure underdrainage by digging a trench and depositing in the bottom of it logs or bundles of brush, or a layer of broken stone; or a channel for the water was formed by setting a line of stone on each side of the trench and joining the two with a third line resting on these two. Apparently it is still the practice in some localities to use such substitutes for ordinary drain tile. Tiles are better, since they are more easily laid and are less liable to get clogged. Tiles are cheaper in first cost, even when shipped considerable distances by rail, than any reasonably good substitute, and the drains are much more durable.

"Tiles are laid simply with their ends in contact, care being taken to turn them until the ends fit reasonably close. In some localities there is apparently fear that the tile will become stopped by fine particles of soil entering at the joints, and consequently it is specified that the joint shall be covered with tarred paper or something of the sort; but in the Mississippi valley, where immense quantities have been laid, no such difficulty has been encountered. With a

very slight fall or even no fall at all, tiles will keep clean if a free outlet is provided and they are not obstructed by roots or trees."

In scientific road making much attention is given to the slope of drains and the computation of the amount of water they can remove. In such work as that under consideration no great degree of refinement is demanded, and the principal thing is to be assured that there is sufficient slope, there being no danger of the grade of the tile being too great. The common practice in farm drainage, however, calls for steeper slopes than are considered necessary by Professor Baker, he being of the opinion that the minimum grade to give good service is ½ inch in 100 feet, while it is undesirable to have a steeper slope than 2 inches in 100 feet.

"The traveled portion of an important road is usually not more than 50 ft. wide, and therefore a single line of tile 2½ to 3 ft. below the bottom of the side ditch, if of adequate size, will give nearly perfect drainage; and a second line will not greatly improve it. If a second line of tile is laid on the other side of the road it will drain only a comparatively small portion not reached by the first line. A single line well below the surface is better than two shallow ones.

"It is generally conceded that for agricultural drainage it is sufficient to place the lines of tile 100 ft. apart, provided they are of reasonable size and at sufficient depth. A tile will give agricultural drainage 50 ft. on either side of it; that is, a tile under only one side ditch will give agricultural drainage of the traveled way. More thorough drainage is required for agricultural than for road purposes, since when damp most soils will pack, which is harmful to agricultural land but beneficial to a road.

"The above seems to prove that one line of tile, if of proper size and at sufficient depth, will afford sufficient drainage for road purposes; but nevertheless it is claimed by competent authorities that two lines are sometimes required. In some localities a stratum of hard-pan near the surface makes it necessary to lay the tile so shallow that two lines are really required; and sometimes the tile is so small or so poorly laid that one line is insufficient.

"Some authorities recommend a line of tile under the middle of the traveled portion. A tile under the middle of the road is a little more effective than one at the same level under the side ditch; but the former is considerably more expensive to lay, since it necessitates more digging—whether the tile is laid before or after the road is graded. With the same depth of digging, a tile under the side ditch is more effective than one under the center of the road. Further, if the tile is under the center, there is liability of the settling of the soil in the trench, which will make a depression and probably a mud hole; and if the tile becomes stopped it is expensive to dig it up, and the doing so interferes with traffic. Finally, if the road is ever graveled or macadamized, the disadvantage of having the tile drain under the center of the road is materially increased."

The question of the provision of side ditches is fully considered by Professor Baker, these acting to carry off the surface water, and also to intercept the water which might otherwise flow from the side hills upon the road. One of the most important things to be observed about such ditches is to provide suitable outlets into available streams or other sources of discharge, since no good can be obtained from ditches which merely collect the water and hold it until it evaporates.

"If it can be prevented, no attempt should be made to carry water long distances in side ditches, for large bodies of water are hard to handle, and are liable to become very destructive. Side ditches should discharge frequently into natural water courses, though to compass this it may in some cases be necessary to carry the water from the high side to the low side of the road. This is sometimes done by digging a gutter or by building a dam diagonally across the road, but both are very objectionable. A better way is to lay a tile or put in a culvert, the amount of water determining which shall be done.

"It is sometimes necessary to carry water a considerable distance in the side ditches, as, for example, when the road is in excavation. This requires deep ditches, which are undesirable and dangerous; and if the grade is considerable, the ditches wash rapidly. In such cases it is wise to lay in a

line of tile under the side ditch, and turn the water from the surface ditch into the tile at intervals. This can be accomplished readily by inserting in the line of porous tile a Y section of vitrified sewer pipe, with the short arm opening up hill. Of course, the short arm, i. e., the vertical arm, need not be as large as the body. If necessary two or three lengths of porous tile may be added at the upper end of the Y to make connection with the bottom of the open ditch. Earth, sods or stones can be piled around the upper end of the tile to make a dam and hold the tile in place.

"As a rule, side ditches will not have too much fall, but sometimes a ditch straight down a hill will have so much fall as to wash rapidly, in which case it is an advantage to put in an obstruction of stone or brush. In extreme cases the bottom of the ditch is paved with stones.

"The surface drainage of a road is provided for by crowning the traveled way and keeping it smooth. The making of the road crowning in the beginning is a matter of construction, and the keeping of the surface smooth is a question of maintenance. It should be remembered that water upon the surface of the road cannot be carried away by the underdrains until after it has penetrated and softened the road surface.

"The slope from the center to the side should be enough to carry the water freely and quickly to the side ditch; and if the surface is kept free from ruts and holes, less crown will suffice than if no attention is given to keeping the surface smooth. If there is not enough crown the water cannot easily reach the side ditches, and the road soon becomes water-soaked.

"On the other hand, the crown may be too great. If the side slopes are so steep that traffic keeps continually in the middle, the road will be worn hollow and retain the water instead of shedding it promptly to the side ditches. With the ordinary method of caring for earth roads, more water stands on a very convex road than on a flatter one. If the crown is too great, it is difficult for vehicles to turn out in passing each other. Again, if the earth is piled too high in the middle, the side slopes will be washed into the side ditches, which not only damages the road, but also fills up the ditches."

After proper construction and drainage details have been provided for a road, it is essential that these elements should be properly cared for, and under this Professor Baker discusses the question of maintenance.

"Proper maintenance is as important as good construction. A distinction should be made between maintenance and repairing. The former keeps the road always in good condition; the latter makes it so only occasionally. A defect which could be remedied in the beginning with a shovelful of earth or a minute's time, if neglected may require a wagon load of earth or an hour's time, besides being in the meantime an annoyance or a danger to traffic. The better the state in which the road is kept, the less are the injuries to it by ordinary traffic and the weather. Water is the natural enemy of good earth roads. The chief object of maintenance should be to keep the surface smooth and properly crowned so that rain water will be shed promptly into the side ditches. These should be kept open so that the water may be carried entirely away from the road."

WATER-WHEEL GOVERNORS.

THE GRADUAL DEVELOPMENT OF ACCURATE AND SENSITIVE APPLIANCES FOR THE SPEED REGULATION OF HYDRAULIC MOTORS.

American Society of Mechanical Engineers.

AT the recent meeting at Chattanooga of the American Society of Mechanical Engineers it had been arranged that a special discussion should be held upon the subject of the speed regulation of hydraulic motors. The result was a collection of notable papers by some of the ablest specialists in the United States in this department of engineering, relating directly and indirectly to the question.

The subject of the precise regulation of the speed of hydraulic motors has become of much more importance than formerly, and since the development of the hydro-

electric power station, the turbine wheel has been called upon to drive the dynamo with a uniformity of rotative speed of a much higher degree than was necessary for ordinary mill machinery. Like many other mechanical problems of difficulty the demand has met with a full response, and today the apparatus for the speed-control of hydraulic motors has attained a degree of perfection beyond even the exacting demands of the electrician.

Of the papers presented at the Chattanooga meeting, two, by Messrs. Mark A. Replogle, and John Sturgess, related to appliances for governing hydraulic turbines, while Mr. George J. Henry discussed the speed regulation of high-pressure water-wheels of the Pelton type. Another paper of importance was contributed by Mr. George A. Buvinger upon the related question of the design of the turbine itself, with its gates and operative mechanism, this naturally having a marked influence upon the effectiveness of the regulating mechanism. To these was appended a paper by Mr. W. O. Webber upon the general subject of efficiency tests of turbine water-wheels, the whole group forming a most valuable contribution to an important department of applied science.

It is manifestly impracticable to give more than a general review of these papers within the limited space here available, and the original communications should be consulted by every engineer who desires to be informed of the latest practice in turbine governing. Some of the more salient points may be brought out, however, and the trend of the discussion indicated.

The paper of Mr. Replogle gives a brief history of his own practical studies in the problem of turbine-governor design, covering more than fifteen years of effort with a variety of designs, and follows with a description of the latest type of governor resulting from the united work of himself and Mr. Nathaniel Lombard, himself another laborer in this same field of research and invention.

Mr. Replogle shows that in order to secure accurate speed regulation of turbine wheels the mechanism must possess qualities which closely resemble what is called reason when exercised by living beings.

"A good water-wheel governor must be able to move the gates slowly or rapidly, as necessity requires. This discrimination savors of good judgment. A good governor must always stop operating before the speed has reached normal.

"In fact it ceases to operate at a speed that is farther from normal than that necessary to cause it to begin operating at the start. This is judgment. A good governor always ceases to operate before the speed has returned to normal; sometimes it ceases a shorter time before the speed is right; and again it ceases a longer time before the speed has exactly reached normal, but always just long enough ahead of time to allow the speed condition to be right after the inertia effects of the water, the new load conditions, and the new power conditions are balanced."

Mr. Replogle says that such conduct would be called reason if performed by a man, a horse, or a dog. We think he might have gone further and expressed doubt if any human governor ever exercised his executive functions in such a satisfactory manner for the regulation of human irregularities of conduct.

The perfected machine resulting from the combined labors of Messrs. Replogle and Lombard is purely mechanical in its action, and involves the use of a differential friction driving system constructed with a rotating spherical pulley acting between two concave leather-lined friction discs. The position of the spherical pulley with respect to the discs is controlled by a centrifugal governor, its position between the discs causing the pulley to be driven in the direction to open or close the gates as the case may be. The rotation of the pulley aso acts upon a screw on its own axis to restore it to the normal position, and there is thus a differential action which is self-correcting to a degree which effectually prevents all hunting or racing.

Passing to the paper of Mr. Henry we see the difficulties which are encountered in high-pressure water-power plants from the velocity of flow. It is, of course, practicable to vary the amount of water impinging upon a wheel by deflecting the nozzle to one side, and thus avoid any change in the volume or velocity of the jet, and in cases in which a required volume of water must be delivered below the wheel

for irrigation purposes such a method may be found desirable even though it is wasteful of energy. By the use of a needle in the axis of the jet the flow of water through the nozzle may be varied without making objectionable changes in the form of the jet of water itself, and in practice the best results are obtained by a combination of the deflecting nozzle and the needle.

The papers of Mr. Sturgess and Mr. Buvinger treat of the important questions of general design as affecting speed regulation, showing the extent to which the difficult work of the governing mechanism may be aided by the designer of the entire plant.

The whole series of papers demand the attention of hydraulic and power-plant engineers everywhere, and the manner in which the subject is thus treated by a body of expert specialists is a very definite endorsement of the policy of the Society in arranging for such discussions as characteristic features of its meetings.

THE DEVELOPMENT OF THE PORTABLE STEAM ENGINE.

ECONOMICAL PERFORMANCES RESULTING FROM THE APPLICATION OF COMPOUNDING AND SUPERHEATING TO ENGINES AND BOILERS OF THE PORTABLE TYPE.

Karl Heilmann—Verein Deutscher Ingenieure

FORMERLY the portable steam engine was considered much in the same class as other agricultural machinery. A horizontal slide-valve engine, bolted to the top of a locomotive boiler, the whole mounted on wheels to be drawn from place to place by animal power, it received but little attention from the engineer by whom it was built, and less by the laborers by whom it was operated.

In England, where the portable steam engine had its origin, the performance has been materially improved as a result of the various competitive trials conducted by the Royal Agricultural Society, but nevertheless such machines have hardly been considered as serious competitors of the more elaborate forms of stationary steam engine, so far as economical performance is concerned.

In Germany, however, the continued efforts of Messrs. Wolf, of Magdeburg, have resulted in the development of a semi-portable engine and boiler, following in general the earlier lines, so far as the use of a horizontal engine on top of a locomotive boiler are concerned, but including the latest developments in compounding and superheating to such an extent as to yield a degree of efficiency equalled only by the very highest types of stationary engines. In a series of papers in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure*, Herr Karl Heilmann discusses the gradual evolution of the portable engine, from its beginning in England in 1840 down to the latest form of the Wolf compound machine, and some abstract of these papers will be found of practical interest.

The earliest Wolf engine resembled very closely its British prototype, being a simple slide-valve engine of eight horse power at 120 revolutions; the locomotive boiler carrying a pressure of 6 atmospheres, this being fairly high for that date, 1862. This machine now rests in the new technical museum in Munich as a mechanical curiosity.

The gradual development of the portable engine included the use of higher steam pressures and a separate cut-off valve and eccentric, and by 1880 machines of this type showed, in official trials a steam consumption of 14.6 kilogrammes of steam, and 2.08 kilogrammes of coal per horse-power-hour.

With the improvement in construction and in performance, came also increase in size, and this naturally led to the idea of compounding. The first compound engine made by Wolf in 1883 was of 48 horse-power, a cross compound machine, with Rider cut-off valves, giving an economy of 8.76 kilogrammes of steam, and 1.328 kilogrammes of coal per horse-power-hour. This was followed by several machines of the same type and various dimensions, these being the result of continual and scientific investigations, using steam pressures up to 10 atmospheres, and the results of the studies which were made with these engines showed that with saturated steam the fol-

lowing thermal performances were attainable: With the simple engine a horse power required 7,300 calories per hour; for the compound engine, exhausting into the atmosphere, 5,630 calories; and for the compound-condensing engine, 4,000 calories; the feed water being taken at zero Centigrade in all three cases.

For further improvement it appeared that recourse must be had to superheating, and it is in this direction that the latest types of the portable engine have shown great susceptibility to development. It must be understood that by this time the portable engine, or at least, the semi-portable type self-contained, but not mounted on wheels, was beginning to find acceptance for stationary and manufacturing purposes, in competition with the regular stationary mill engine.

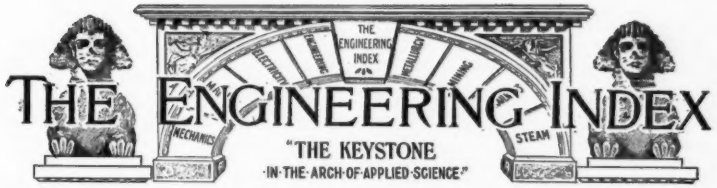
Experiments with independent superheaters gave very encouraging results, and in consequence the steam generator of the Wolf machine was redesigned to include superheating apparatus. The form of superheater selected was that of a spiral coil of pipe placed in the smoke box of the locomotive boiler, this receiving the direct heat of the gases of combustion after passing through the tubes of the boiler and permitting of ready access for inspection and cleaning. With the design of the superheated steam engines every precaution was taken to prevent heat losses, the steam pipes being carried through the steam space of the boiler, the cylinders enclosed in the steam dome, and hence provided with the most effective steam jacketing, while the proportion of heating surface in the superheater was made such as to give about 100 degrees Centigrade superheat, with a boiler pressure of 12 atmospheres. These later engines, built in sizes from 150 to 220 horse-power, have shown economical performances equalled by but few stationary engines. Tests by such engineers as Professors Lewicki, Gutermuth, and Josse, upon different engines, and at various times, show that a brake horse-power is obtained with steam consumptions ranging 5.6 to 4.67 kilogrammes of steam per hour (12.32 to 9.97 pounds), and a coal consumption of 0.633 to 0.567 kilogrammes (1.34 to 1.25 pounds).

Herr Heilmann gives a comparative table showing the performances of other first-class steam engines of recent make as well as of steam turbines, and these figures are interesting.

Thus a tandem Sulzer compound engine gave a steam consumption of 5.67 kilogrammes per horse-power-hour, or 12.47 pounds; and a triple-expansion engine by the Görlitz Machine Works a consumption of 4.53 kilogrammes. The best performance shown for a steam turbine is that of a Brown-Boveri-Parsons machine, which gave a brake horse-power with a steam consumption of 4.85 kilogrammes per hour, or 10.67 pounds; while the Zoelly turbine gave 5.78 kilogrammes, and the Parsons, among others, 6.4 kilogrammes.

There are several reasons which account for the excellent performance of the Wolf portable engines. Both engines and boilers are well designed and proportioned. The boiler, being internally fired is free from any losses due to air leakages, so common with brickwork settings, while the location of the superheater, directly in the smoke-box, enables the heat not abstracted in the boiler to be applied to the steam. A distinct advantage is the avoidance of long exposed steam mains between the superheater and the cylinder, the steam pipe passing directly to the engine without opportunity for any of those losses which, as Dr. Berner's experiments have shown are so apt to occurr in the transmission of highly superheated steam. The best results of the Wolf engines were obtained with steam superheated 150 to 170 degrees C. above the temperature of saturation, and the full benefit of this degree of superheat is very apt to be lost if there is any material distance between the engine and the superheater. The later Wolf engines also use an interheater between the two cylinders, this interheater also formed of a coil in the smoke-box of the boiler, an excellent and effective arrangement, but only practicable when the engine is so close to the boiler as to form practically one machine.

The results above detailed show how, by the careful application of scientific principles to design and construction, such an unpromising subject as the ordinary portable engine may be converted into a machine of the very highest thermal and commercial efficiency.



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Curves for Reinforced Arches. Daniel B. Luten. Gives illustrations, with explanation, of several methods of design and reinforcement. 1000 w. Eng Rec—April 14, 1906. No. 76317.

"Horseshoe" Concrete Arches. Daniel B. Luten. Illustrations with description of the construction of this type of arch as built on the Indiana railways. 1200 w. R R Gaz—April 20, 1906. No. 76151.

Special Design of Centers for Parabolic Concrete Arch Bridge, Washington, D. C. Shows the method of erection of the arch center of the 16th St. bridge in Washington, D. C. Ills. 600 w. Eng News—April 19, 1906. No. 76133.

The Computation of the Volume of Arches with Inclined Faces (Berechnung des Kubikinhalts von Gewölben mit Schiefem Stirnanzug). Alfred Wessely. Deriving formulas for the calculation of the cubic contents of masonry arches and

We supply copies of these articles. See page 477.

vaults of semicircular shape with a slope or batter to the external faces. A number of cases are worked out. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—March 16, 1906. No. 76223 D.

Bascule.

New Type of Bascule Bridge. Enos Brown. Illustrates and describes a bridge of the Page bascule type, built at San Francisco. 700 w. Sci Am Sup—April 21, 1906. No. 76136.

Designs.

Bridges. Willis Whited considers points in bridge designing. General discussion follows. 4800 w. Pro Engrs Soc of W Penn—April, 1906. No. 76352 D.

Eye-Bars.

New Facts About Eye-Bars. Discussion of paper on this subject, by Theodore Cooper. Ills. 3800 w. Pro Am Soc of Civ Engrs—April, 1906—No. 76394 E.

Overloads.

Concerning the Investigation of Overloaded Bridges. William J. Watson. Discusses the great discrepancy between theory and observed results, and points concerning the design of new work and the investigation of old work. 3000 w. Pro Am Soc of Civ Engrs—April, 1906. No. 76392 E.

Reinforced Concrete.

A Flat Span Reinforced Concrete Bridge at Memphis. A highway bridge of 100 ft, through span is illustrated and described. The cost was $17,500. 1100 w. Eng Rec—April, 1906. No. 75983.

Reinforced Concrete Arch Bridge at Peru, Indiana. Daniel B. Luten. Illustrates one of the longest reinforced-concrete bridges ever erected. It crosses the Wabash River with seven arches. 2500 w. Eng News—March 29, 1906. No. 75863.

Schuylkill.

Schuylkill River Bridge. Illustration and description of a bridge at Philadelphia on the Pennsylvania R. R. The approaches are masonry spans 60 ft. across with piers 70 ft. through, and the abutments of the steel structure are 25 ft. through. The steel span is a Pratt truss deck bridge. 600 w. Ry & Loc Engng—May, 1906. No. 76372 C.

Swing Bridge.

The Rodah Bridge. An illustrated description of the Rodah swing bridge at Cairo. It is built on seventeen piers, with fifty-five main girders. 600 w. Engr, Lond—April 6, 1906. No. 76084 A.

Viaduct.

Rebuilding the Rondout Viaduct. This viaduct on the West Shore R. R. is described and illustrated. The heavy traffic recently sent over the road, made it necessary to strengthen the structure, and the work is described. 4700 w. Eng Rec—April 7, 1906. No. 75981.

CONSTRUCTION.

Cofferdams.

Steel Piling Cofferdams for Bridge Piers. Illustrates and describes cofferdams used in building piers for a bridge near Chillicothe, Ohio. 1000 w. Eng Rec—April 21, 1906. No. 76326.

Columns.

Diagrams for the Strength of Steel and Wooden Columns. Louis Ross. Gives diagrams, illustrating their use by examples. 600 w. Eng News—April 26, 1906. No. 76340.

Concrete.

The Possibilities of Concrete Construction from the Standpoint of Utility and Art. William L. Price. Read before the Assn. of Am. Portland Cement Mfrs. Discusses the dangers and possibilities of this material. 1600 w. Sci Am Sup—April 28, 1906. No. 76382.

Fire Proofing.

Fire-Resisting Construction and the Ultimate Life of Mercantile Buildings: A Plea for Better Constructive Methods. J. K. Freitag. Comments on the justness of English criticism of American practice, as shown in a recent discussion of a paper by Reuben A. Denell. 3800 w. Eng News—April 26, 1906. No. 76342.

The Farwell, Ozmun, & Kirke Co., Warehouse at St. Paul. W. H. Dillon. Description of fireproof construction in reinforced concrete. 1800 w. Eng Rec—April 21, 1906. No. 76330.

Loading.

In Relation to Loading Long Structural Material. T. S. Kirk. Reviews the changes which have made the loading question much more difficult in recent years, and discusses briefly some of the questions. General discussion follows. 15500 w. Pro Ry Club of Pittsburgh—Jan. 26, 1906. No. 76386 C.

Reinforced Concrete.

A Garage of Reinforced Concrete. Illustrated description of a building in West 93d St., New York, designed as a public garage for the storage and care of automobiles. There are three floors and a basement. 800 w. Archts & Bldrs Mag—April, 1906. No. 75916 C.

Computations for Ceilings and Beams in Reinforced Concrete (Calcul des Hourdis en Béton Armé). P. Cafourier. Deriving simple formulas for the distribution of reinforcing rods for various loads and spans. 1500 w. Génie Civil—April 7, 1906. No. 76220 D.

Recent Developments in Reinforced Concrete Construction. M. M. Sloan. Comments on the causes that have led to the rapid advance of reinforced concrete, discussing details, elementary principles, advantages and limitations. Ills. 2800 w. Archts & Bldrs' Mag—April, 1906. Serial. 1st part. No. 75917 C.

We supply copies of these articles. See page 477.

Reinforced Concrete Sand Bins. Illustrated description of a cluster of sand-storage bins, built in New York City of reinforced concrete. 100 w. Eng Rec—April 21, 1906. No. 76327.

Reinforced Concrete Work at the New Railway Terminal Station at Atlanta, Ga. Illustrated detailed description of a terminal station where this material has been used in a variety of ways. Also editorial. 4500 w. Eng News—April 12, 1906. No. 76049.

The Economical Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures. Continued discussion of paper on this subject by John S. Sewell. 8400 w. Pro Am Soc of Civ Engrs—April, 1906. No. 76393 E.

The Reinforced Concrete Bath House Failure at Atlantic City, N. J. Photographs, with description of the causes which led to the failure. 600 w. Eng News—April 5, 1906. No. 75953.

See also Civil Engineering, Bridges.

Retaining Wall.

Plumbing a Leaning Retaining Wall and Bridge Abutment. Lindsay Duncan. Illustrates and describes work on a viaduct at Pueblo, Colo. 600 w. Eng News—April 5, 1906. No. 75951.

Roads.

Good Roads. Frank Soule. Points out benefits derived from good roads, considers some of the characteristics such roads should possess, and urges improvement of the roads in California. 3300 w. Cal Jour of Tech—Feb., 1906. No. 75958 C.

Roofs.

Difficult Reconstruction of a Church Roof. Describes the original design and shows how changes made in the building weakened the framework, and gives an illustrated description of difficult repairs, made without injuring the costly interior decorations. 2500 w. Eng Rec—March 31, 1906. No. 75884.

Steel Structures.

San Francisco Buildings after the Disaster. Reports favorably concerning the resistance of steel structures to earthquake and fire, and some plans for reconstruction. 3000 w. Ir Age—April 26, 1906. No. 76321.

Steelwork Details of the New Office Building of the New York Central R.R. Describes interesting details of the building under construction at Depew Place, New York City, where arrangements have been made for very heavy loads. 2500 w. Eng Rec—April 7, 1906. No. 75987.

Structural Steel Work in a New York Office Building. Illustrates and describes the construction of one of the tallest of steel-cage structures in New York City. 2200 w. Eng Rec—April 14, 1906. No. 76316.

Tunneling.

A New Method of Rock Tunneling Under City Streets. Frank Richards. Illustrates and describes the method of driving rock tunnel heading with drills and "Radialaxe" channelers. 1800 w. Eng News—April 5, 1906. No. 75948.

The New Bergen Hill Tunnel of the Lackawanna. J. H. Philips. Detailed description, with diagrams, of this new tunnel to relieve congestion at this point on the Lackawanna R. R. 1000 w. R R Gaz—April 6, 1906. No. 75954.

Underpinning.

Underpinning Old Walls with Steel Columns. Illustrates and describes the method of underpinning an old brick wall with double pipe columns in the course of erecting a tall office building in New York City. 1400 w. Eng Rec—March 31, 1906. No. 75886.

MATERIALS OF CONSTRUCTION.

Cement.

The Clinkering Curves of Portland Cement. Fred Vickery. Describes investigations made and gives results obtained. 1800 w. Cal Jour of Tech—Feb., 1906. No. 75959 C.

The New Kiln Firing Process at the Lawrence Cement Co.'s Siegfried Mill. Information concerning the new method introduced in this mill in Siegfried, Pa. Ills. 1000 w. Eng Rec—April 7, 1906. No. 75986.

Cement Burning.

The Gas Producer in the Manufacture of Cement (Der Generator in der Zementindustrie). C. Naske. A discussion of the heat balance in the cement kiln, with especial reference to gas firing. 2500 w. Zeitschr d Ver Deutscher Ing—April 7, 1906. No. 76206 D.

Fire Brick.

Fire-Brick Work. R. P. King. Considers important points in the building of fire-resisting structures, particularly in reference to boiler setting. 2000 w. Am Mach—Vol. 29, No. 15. No. 76034.

Marble.

Marble in the Northwest. J. C. Rathbun. Introductory remarks on varieties of marble and the qualities that determine their value. Information concerning the deposits in the northwest, especially in Washington and Alaska. 2000 w. Min Wld—April 7, 1906. No. 75979.

MEASUREMENT.

Surveying.

Common Sources of Error in Field Work. A. M. Shaw. Gives sources of error and their suggested remedies. 700 w. Eng News—April 19, 1906. No. 76131.

Field Methods of Triangulation in the

Plains Country in Montana. John T. Stewart. Abstract of a paper read at the annual meeting of the Illinois Soc. of Engrs. & Survs. Describes the field methods of triangulation used in Montana in establishing geodetic positions for the control of a topographic survey. 5500 w. Eng News—April 12, 1906. No. 76050.

Surveying on the Farm. A. S. Kenyon. Explains the use of the miner's triangle, the water level, leveling operations, and boring rods. Ills. 1800 w. Sci Am Sup—April 28, 1906. No. 76383.

The Mayer and Wiesmann Theodolite (Tachéomètre A. Mayer et E Wiesmann). L. Fonjallaz. Illustrating and describing an improved transit-theodolite, especially adapted for tunnel work and used in connection with the work on the Simplon Tunnel. 2500 w. Bull Tech de la Suisse Romande—April 10, 1906. No. 76266 D.

MUNICIPAL.

Fire Loss.

The San Francisco Disaster: Earthquake and Fire Ruin in the Bay Counties of California. An account of this disaster, with map showing the approximate extent of the burned district. 4500 w. Eng News—April 26, 1906. No. 76343.

Fire Protection.

See Civil Engineering, Water Supply.

Pavements.

Vitrified Brick for Paving Purposes. Directions for laying brick pavements prepared from the experience of eminent engineers. 2500 w. Eng Rec—April 14, 1906. No. 76320.

Refuse.

Disposal of Municipal Refuse, and Rubbish Incineration. H. de B Parsons. Gives data on the subject of municipal refuse and describes the rubbish incinerating plant in Delancey Slip, Manhattan, with the adjoining electric lighting station, which utilizes the heat produced to light the Williamsburg Bridge. Ills. 6500 w. Pro Am Soc of Civ Engrs—April, 1906. No. 76391 E.

Sewage.

Disposal Plants in the State of Wisconsin. John F. Icke. An illustrated article reviewing the plants and processes in use. The plant at Madison is fully described and reported. 11500 w. Wis Engr—March, 1906. No. 76094 D.

Report on Sewage Purification Experiments at Columbus, O. A summary review of the tests, as given by George A. Johnson, with editorial. 5000 w. Eng News—April 5, 1906. No. 75952.

The Johannesburg Municipal Sewage Scheme from a Bio-Chemical Point of View. W. C. C. Pakes sketches the proposed scheme and discusses it from the view of modern facts and theories. Considers it sound from both a sanitary and commercial point of view. Discussion. 7500 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1906. No. 76146 E.

Sewers.

Breakage in Sewer Conduits: Its Cause, Effect and Prevention. Alexander Potter. Read before the Sanitary Sec. of the Boston Soc. of Civ. Engrs. Gives facts bearing on this subject, and discusses the behaviour of cement and vitrified pipe and sewer construction. 3500 w. Munic Engng—April, 1906. No. 75936 C.

Cost of Cleaning a Large Brick Sewer. Frederick L. Ford. Read before the Conn. Soc. of Engrs. Reports the cost of cleaning the Franklin avenue sewer, of Hartford, Conn. 1000 w. Munic Engng—April, 1906. No. 75935 C.

New Collector for the Sewage Purification Plant at Hamburg (Le Nouveau Collecteur et la Station d'Epuration des Eaux d'Egouts de Hambourg). Describing especially the sinking of the inverted siphon across the inner harbor. 2000 w. 1 plate. Génie Civil—March 24, 1906. No. 76214 D.

WATER SUPPLY.

Filtration.

Reinforced Concrete Filter Bed Walls and Roofs, Indianapolis, Ind. William Curtis Mabee. An illustrated article describing the general design and methods of construction, and reporting cost. 3500 w. Eng News—April 26, 1906. No. 76336.

The Official Prussian Tests of the Jewell Water Filter. An account of the tests conducted by the Royal Prussian Institution and the results. 6000 w. Eng Rec—April 21, 1906. No. 76324.

The Washington Water Filtration Plant. E. D. Hardy. Gives illustrations and particulars of this plant for treating the water of the Potomac River by slow sand filtration. 1200 w. Eng Rec—April 7, 1906. No. 75982.

Fire Protection.

Underwriters' Committee of Twenty on Fire Protection in New York, Chicago and Detroit. Information from recent reports, relating to the water supplies, based on thorough investigations made by experts. Also editorial. 6000 w. Eng News—April 26, 1906. No. 76337.

Water Supply, Fire Protection and Conflagration Hazard at San Francisco, Cal. Outlines some of the conditions prevailing in the city at the time of the disaster, and gives an abstract of the report of the Committee of Twenty of the National Board of Fire Underwriters.

We supply copies of these articles. See page 477.

3300 w. Eng News—April 26, 1906. No. 76341.

Subterranean Water Supply. John Richards. Read before the Engng Cong., Lewis & Clark Ex. Refers to conditions on the Pacific Coast, discussing the development of high-pressure centrifugal pumps. Ills. 2500 w. Jour Assn of Engng Socs—Feb., 1906. No. 76113 C.

Ground Water.

Preliminary Investigations of Water Supply (Ueber Voruntersuchungen für Wasserversorgungen). Dr. Philipp Forchheimer. Describing methods of making borings, determination of quality and quantity of flow of ground water, temperature measurements, and similar preliminary work for water-supply from wells and springs. Discussion. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—March 30, 1906. No. 76225 D.

Irrigation.

A New Irrigation System. M. Alger, in *Am. Home & Garden.* Illustrated description of a system invented by Dr. August Koren, Jr., a Norwegian physician, especially adapted for gardens and small farms. 1000 w. Sci Am Sup—April 7, 1906. No. 75930.

The Inundation of the Salton Basin by the Colorado River and How It Was Caused. Allen Day. Describes and illustrates an inundation of great magnitude caused by work in connection with irrigation of a portion of the Colorado desert. 1700 w. Sci Am—April 14, 1906. No. 76037.

Ozone.

Apparatus for the Sterilization of Water by Means of Ozone. Dr. Gg. Erlwein. Translated from *Gesundheit.* Illustrates and describes various outfits for ozone sterilization, adapted to different requirements. 1800 w. Sci Am Sup—April 14, 1906. No. 76038.

Pumping Station..

The Pumping Station at Messein for the Supply of the City of Nancy (Usine Elévatoire de Messein pour l'Alimentation de la Ville de Nancy). A. M. J. Mauduit. An illustrated description of the station on the Moselle, using centrifugal pumps driven by electric motors. The motive power is derived from the river. 3000 w. Génie Civil—March 31, 1906. No. 76217 D.

Rates.

The Principles Governing the Valuation for Rate-Fixing Purposes of Water Works Under Private Ownership. Arthur L. Adams. Read before the Engng. Cong., Lewis & Clark Ex. Considers in detail the fundamental factors influencing value. 7500 w. Jour Assn of Engng Socs—Feb., 1906. No. 76114 C.

Reconstruction.

The Reconstruction of the Ottumwa, Ia., Water Works. A new pumping station and other improvements are illustrated and described, and the general plan of the system outlined. 2000 w. Eng Rec—March 31, 1906. No. 75885.

Reservoirs.

Reservoir at Ft. Meade, S. D. S. H. Rea. Illustrated description of a recently completed reservoir constructed of reinforced-concrete. 2800 w. Munic Engng April, 1906. No. 75934 C.

Waste.

The Business View of Water Waste. Editorial showing that frequently the prevention would cost more than the waste, and that each problem must be studied separately. 1200 w. Eng Rec—March 31, 1906. No. 75880.

Water Softening.

Practical Water Softening for Municipalities. C. Herschel Koyl. Considers methods of improving the supply for drinking and industrial uses. 2500 w. Munic Jour & Engr—April 4, 1906. No. 75942 C.

Water Works.

The New Water-Works and Reinforced Concrete Conduits of the City of Mexico. James D. Schuyler. Illustrations and brief description of a system for supplying pure spring water under ample pressure. 1200 w. Eng News—April 19, 1906. No. 76129.

Well Drilling.

The Work of Well-Drilling Machines on the Pennsylvania R.R. Low Grade Freight Line. W. R. Hulbert. An illustrated article describing the work done by these machines and the results attained. 1500 w. Eng News—April 12, 1906. No. 76051.

WATERWAYS AND HARBORS.

Antwerp.

Extension of the Port of Antwerp. An account of the proposed enlargement of the port, showing plan that will make it one of the most commodious ports in the world. 2000 w. Engr, Lond—April 13, 1906. No. 76307 A.

The Improvements at the Port of Antwerp (Les Nouveaux Agrandissements du Port d'Anvers). A description, with map of the plans for the enlargement of the port of Antwerp, including the straightening of the channel of the Scheldt, and the extensive new docks. 1800 w. Génie Civil—March 17, 1906. No. 76213 D.

Bohemia.

The Construction of the Lateral Canal from Wranan to Horin (Der Bau des Lateralkanales von Wranan nach Horin). W. Rubin. With illustrations of the construction work on a waterway 10 kilometres long by the Moldau in Bohemia, with details of the locks for a fall

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of 9 metres. 4000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 30, 1906. No. 76224 D.

Canals.

See Industrial Economy.

Channels.

The Buoying and Lighting of Navigable Channels. Brysson Cunningham. An illustrated article discussing the essential features of any satisfactory system with especial reference to English practice, but giving also the regulations of other countries. 4000 w. Engng—April 6, 1906. Serial. 1st part. No. 76078 A.

Drainage.

The Drainage of the Florida Everglades. S. L. Lupfer. An interesting account of the difficulties met in surveying the Everglades, discussing the question of canal routes, and describing the dredges to be used. 4000 w. Eng News—April 5, 1906. No. 75947.

Dredge.

The Sea Going Bucket Dredge, Fedor Solodoff (Der Seetuchtige Eimerbagger Fedor Solodoff). A. v. Overbeeke. Illustrated description of a ladder bucket dredge, with suction and discharge pipes for use in the sea of Azov, at the mouths of the Danube and the Don. 1500 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 7, 1906. No. 76204 D.

Excavation.

Cost of Canal Excavation Through Peat and Soft Material. Information concerning the work accomplished by a Lidgerwood duplex traveling cableway of special design, in construction at the Hennepin Canal, near Wyanet, Ill. 900 w. Eng Rec—April 7, 1906. No. 75984.

Excavator.

A German Excavator on the New York Barge Canal. Emile Low. Brief account of the work near Oneida Lake, and an illustrated description of the type of excavator with transporter used. 700 w. Eng Rec—April 21, 1906. No. 76325.

Levees.

Levee and Drainage Works at Memphis. Describes the area requiring protection along the banks of the Mississippi, the levees, and a pumping plant having several unusual features. 4500 w. Eng Rec—April 21, 1906. No. 76323.

Obstructions.

Submarine Sweeps for Locating Obstructions in Navigable Waters. Francis C. Shenehon. Illustrates and describes the Lake Survey Pontoon Speed Sweeps, and describes other forms tried. 3300 w. Eng News—April 26, 1906. No. 76338.

Ostend.

The Ostend Harbor Extensions. Gives briefly the history of this port of Belgium, and describes the harbor improvements in progress. 2500 w. Engng—April 13, 1906. 76199 A.

Panama.

Concerning the Gatun Dam. Substance of the testimony of Prof Wm. H. Burr, before the Senate Committee, favoring the sea-level canal; and of Frederic P. Stearns in answer to the criticisms of the design of this dam. Also editorial. 10500 w. Eng News—March 29, 1906. No. 75865.

Recent Controversy and Conditions at Panama. Fullerton L. Waldo. A letter discussing the sea-level plan and the work thus far accomplished on the isthmus. 1800 w. R R Gaz—April 20, 1906. No. 76150.

The Probable Tonnage of the Panama Canal. Editorial discussing the views of John F. Wallace, Prof. Emory R. Johnson, and the estimates published, and the bearing on the type of canal to build. 3500 w. Eng News—April 19, 1906. No. 76132.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Laying.

Cable Gear for a new Japanese Cable Ship. Gives plan and elevation of the ship, and illustrated description of the machinery, especially the combined picking-up and playing-out machine. 1500 w. Elect'n, Lond—March 23, 1906. No. 75901 A.

Maintenance.

Care and Maintenance of Equipment. R. A. Walker. Read before the Iowa Telephone Assn. Considers the care of office equipment, cables and aerial lines, and instruments. 2000 w. Elec Rev, N Y—April 14, 1906. No. 76054.

Pupin System.

Observations on the Pupin Telephone System (Beobachtungen an Telephonleitungen Pupinschen Systems). Robert Nowotny. An account of experience with the long-distance line between Vienna and Innsbruck showing the improvement due to the Pupin loading coils. 3000 w. Elektrotechnik u Maschinenbau—April 1, 1906. No. 76255 D.

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Space Telegraphy.

The Bell Tetrahedral Kite in Wireless Telegraphy. An illustrated account of the recent successful transmission of messages between Long Island and Ireland, by means of kite-supported aerials. 800 w. Sci Am—April 21, 1906. No. 76134.

Wireless Telegraphy by Means of Kites. Waldon Fawcett. An illustrated article describing the experiments being carried out by Dr. A. Graham Bell, in the utilization of tetrahedral kites as an aid in wireless telegraphy. 500 w. Elec Rev N Y—April 7, 1906. No. 75993.

Telephony.

Telephone Engineering as a Profession. C. E. Scribner. Discusses phases of telephone engineering and the problems, and the opportunity for young engineers in this field. 4500 w. Sib Jour of Engng—March, 1906. No. 76095 C.

Telephone Engineering. J. J. Carty. Discusses the true scope of telephone engineering, presenting a typical problem in telephone management, illustrating the points made. 10200 w. Am Inst of Elec Engrs—March, 1906. No. 76116 D.

The Application of Self-Induction to Long-Distance Telephony. Aims to give some account of the theory now generally admitted to be correct, and to show its application to the problem of long-distance telephony. 4000 w. Elec Engr, Lond—April 6, 1906. No. 76071 A.

The Telephone Cable. G. S. Macomber. Illustrates and describes the manufacture of the standard telephone cable, with information relating to their use. 2200 w. Sib Jour of Engng—March, 1906. No. 76096 C.

DISTRIBUTION.

Cables.

Comments on Underground Cable Practice. Wallace S. Clark. Discusses the advisability of omitting metallic sheaths, and mentions other features of cable materials, and construction, and of tests. Gives specifications adopted by the Rubber-Covered Wire Engineers' Association. 2500 w. Am Inst of Elec Engrs—April 27, 1906. No. 76369 D.

Conduits.

Conduit Wiring for Electric Installations. L. M. Waterhouse. Abstract of a paper read before the Nat. Elec. Contractors' Assn., Lond. Discusses methods of conduit wiring, the materials, etc. 2000 w. Elec Engr, Lond—March 23, 1906. No. 75898 A.

The Long-Distance Underground Conduit System of the American Telephone and Telegraph Company between New York, N. Y., and New Haven, Ct. Illustrates and describes the recently completed conduit system from Stamford to New Haven, which connects with the previously built line to New York. The construction work is described. 1900 w. Elec Rev, N Y—April 14, 1906. No. 76053.

Insulation.

Standardizing Rubber-Covered Wires and Cables. John Langan. Emphasizes the importance of using the best Para rubber, and gives tensile and other tests for determining it; and proposes a set of specifications for cables. 5000 w. Am Inst of Elec Engrs—April 27, 1906. No. 76368 D.

Rotary Converters.

Some Notes on the Regulation of Rotary Converters. Alfred Still. Explains how compound winding of rotary converters enables the pressure across brushes to be maintained constant at all loads. 1400 w. Elec Rev, Lond—April 13, 1906. No. 76142 A.

Sub-Station.

Transformer Sub-Station at the St. Lazare Railway Station, Paris (Sous-Station de Transformation d'Energie Electrique de la Gare Saint-Lazare, Paris). J. Vinson. The primary current is supplied at 5000 volts and 25 cycles from the Molineaux generating station, and transformed to a continuous current at 125 volts for use in the railway terminal. 2000 w. 1 plate. Génie Civil—March 17, 1906. No. 76211 D.

Wires.

Some Notes on Wires. Thomas Carter. Notes compiled for the purpose of comparing different wires available for electrical resistance of various types. 1000 w. Elec Rev, Lond—March 30, 1906. No. 76004 A.

ELECTRO-CHEMISTRY.

Electric Furnaces.

Potential Regulation for Large Electric Furnaces. H. R. Stuart. Considers methods for regulating the current supplied to electric furnaces, and the devices used. Ills. 1500 w. Elec Jour—April, 1906. No. 76354.

Electric Smelting.

Electric Smelting of Magnetite Ores: Successful Experiments at Sault Ste Marie. An address delivered by Dr. Eugene Haavel before the Canadian Club, Toronto, on March 12, 1906. An account of the experimentation on Canadian ores at the Soo, giving illustrated description of the electric furnace. The results are pronounced successful. 3800 w. Can Engr—April, 1906. No. 75923.

Electrolytes.

Factory Scale Experiments with Fused Electrolytes. Edgar A Ashcroft. Deals with special lines of practical electrolytic work with which experimental trials have been conducted on a scale comparable to

factory conditions. Ills. 3000 w. Elec Chem & Met Ind—April, 1906. Serial. 1st part. No. 76028 C.

Electrothermics.

Electrothermics of Iron and Steel. Ch. A Keller. Abstract of a paper read before the Faraday Soc. Gives results obtained in 1905 in the production of iron and steel by the electric furnace at the Livet Works, France. 1500 w. Ir & Coal Trade Rev—April 13, 1906. No. 76311 A.

Hypochlorite.

The use of Electrolytic Hypochlorite as a Sewage Sterilizing Agent in the United Kingdom. John B. C. Kershaw. Gives details of the hypochlorite cells which have been patented and worked in the United Kingdom. Ills. 2700 w. Elec Chem & Met Ind—April, 1906. No. 76025 C.

Nitrogen.

Fixation of Atmospheric Nitrogen. Prof. Philippe A. Guye. Slightly abridged paper read before the Swiss Soc. of Nat. Science. A summary of the application of modern principles of physical chemistry to the combustion of nitrogen. Also editorial. 5000 w. Elec Chem & Met Ind—April, 1906. No. 76026 C.

Southern Water-Powers and Fertilizer. C. H. Z. Caracristi. Deals with the process of obtaining nitrogen from the atmosphere, reviewing the papers by Sir William Crookes and Professor Sylvanus P. Thompson, and the work at the factory in Norway. 5500 w. Mfrs Rec—April 12, 1906. No. 76043.

ELECTRO-PHYSICS.

Flux-Distribution.

Flux-Distribution in Machines with Commutating Poles. Thomas F. Wall and Stanley P. Smith. Experimental investigations are described and discussed. 1500 w. Elect'n, Lond—April 6, 1906. No. 76074 A.

Harmonics.

The Utility of Methods of Avoiding Harmonics in Alternating-Current Machinery (Sur l'Utilité et les Moyens d'Eviter les Harmoniques dans les Appareils à Courants Alternatifs). F. C. Guéry An exhaustive study of harmonic action in high-tension alternating-current circuits, showing how such action may be checked at its inception. 9000 w. Bull Soc Ind des Electriciens—March, 1906. No. 76267 G.

Magnetic Field.

An Investigation into the Periodic Variations in the Magnetic Field of a Three-Phase Generator by Means of the Oscillograph. G. W. Worrall and T. F. Wall. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. A report of investigations made to obtain experimental records of the variations referred to under various conditions of load. 1100 w. Elect'n, Lond—April 13, 1906. No. 76194 A.

Magnets.

Method of Design for Magnet Windings. F. Albert Willard. Outlines methods which may be used in the design of any winding, and if followed closely will give accurate results. 800 w. Elec Wld—April 21, 1906. No. 76184.

GENERATING STATIONS.

Accumulators

Economic Considerations in the Employment of Storage Batteries. J. R. Salter. Abstract of paper and discussion before the Manchester Soc. of the Inst. of Elec. Engrs. Discusses the advantages claimed, and concludes that they are not justified by the cost at which they are obtained. Also editorial 5500 w. Elect'n, Lond—April 6, 1906. No. 76075 A.

Maximum efficiency of a Storage Battery. Benjamin F. Bailey. Describes a test made to get the highest possible efficiency from a storage battery. The experiments showed a quantity efficiency of almost 100 per cent, and a watt-hour efficiency of 91.8 per cent. 700 w. Elec Wld—April 21, 1906. No. 76186.

Bohemia.

Hohenfurth Plant in Bohemia. C. L. Durand. Illustrated description of the hydraulic station recently erected on the Moldau river. The current is distributed by a high-tension line operated on the three-phase system, and is used mainly in paper-making establishments. 2500 w. Elec Rev, N Y—March 31, 1906. No. 75846.

Boosters.

The Application of Automatic Boosters in Electric Stations (Anwendung von Selbsttätigen Zusatzmaschinen für Elektrizitätswerke). L. Schröder. Discussing especially the use of auxiliary dynamos in connection with the operation of street railway power stations. 3000 w. Elektrotechnik u Maschinenbau—April 8, 1906. No. 76256 D.

Commutators.

Computations for the Number of Elementary Groups and the Pressure between two Adjoining Commutator Segments (Berechnung der Zahl der Elementengruppen und der Spannung Zwischen Zwei Benachbarten Kollektorlamellen). N. Gennimatas. A mathematical discussion of the distribution of voltage between commutator segments. 2500 w. Elektrotechnik u Maschinenbau—March 25, 1906. No. 76254 D.

New Methods in the Care of Brush Arc Generator Commutators. C. M. Green. Directions with illustrations.

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1000 w. Elec Wld—April 7, 1906. No. 76090.

Costs.

Rates for Electric Current in Chicago. A report to the Gas, Oil and Electric Light Committee of the Chicago City Council by B. J. Arnold and William Carroll. 3800 w. Eng Rec—April 14, 1906. No. 76315.

The Cost of Electricity Per Unit from Private Electrical Plants. Review of a paper by Wilson Hartnell, before the Leeds Loc. Sec of the Inst. of Elec. Engrs., criticizing the accuracy of some statements made. 1200 w. Elec Engr, Lond—March 23, 1906. No. 75899 A.

Extensions.

Recent Extensions at the Manchester Electricity Works. An illustrated account of some of the more important extensions recently made. The present article describes the 500 k.w. La Cour motor-converters, the principle and design. 2700 w. Elect'n, Lond—March 30, 1906. Serial. 1st part. No. 76007 A.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Hydro-Electric.

Hydro-Electrical Installations of Upper Italy. From a paper read by G. Semenza, before the Society of Civil Engrs. of France. Explains why the installation of hydro-electrical machinery is of immense value to Italy, and gives information of a number of important instalments. 3000 w. Elec Engr, Lond—March 30, 1906. No. 76003 A.

Hydro-electric Development in the Adirondacks. Illustrates and describes the plant at Hannawa Falls, where the water of the Raquette River drives the electric generators, and turns the wheels that operate the grinders of a pulp mill. 3000 w. Elec Wld—April 21, 1906. No. 76183.

Hydro-Electric Power Plants of California. C. W. Whitney. Reviews briefly the electrical and hydraulic developments of some of the typical power plants of the State. Ills. 7500 w. Cal Jour of Tech—Feb., 1906. No. 75957 C.

The Electric Station at Wagnen on the Aar (Das Elektrizitatswerk Wangen a. d. Aare). L. Zodel. A fully illustrated description of a plant developing 9000 h. p. from the hydraulic power of the Aar, being the largest hydro-electric station in Switzerland. Two pairs of horizontal turbines are direct-connected to each dynamo. Two articles, 3000 w. Schweiz Bauzeitung—April 7, 14, 1906. No. 76251 each B.

The Hauterive Power Station (Usine de Hauterive). A. Weber. A fully illustrated description of the hydro-electric station on the Sarine, in the Canton of Fribourg, Switzerland, for the development of 10,000 horse power. 5 articles, 8000 w. Bull Tech de la Suisse Romande. Jan. 25, Feb. 10, 25. March 10, 25, 1906. No. 76263 each D.

The Hydraulic Power Development of the Animas Power and Water Co. George M. Peek. Illustrated description of this plant in Colorado, built by a company incorporated for the purpose of building irrigation canals, reservoirs, and developing water power. 1600 w. Eng Rec—April 14, 1906. No. 76319.

The Hydro-electric Plant of the Animas Power and Water Company. Malcolm Lloyd. Illustrated description of a hydraulic power plant in the southwestern part of Colorado which promises to revolutionize the mining and commercial industries of the region. 3500 w. Elec Rev, N Y—April 21, 1906. No. 76158.

The Sill Electricity Works. Illustrated description of one of the most important hydro-electric plants recently installed in the Austrian Alps. It is designed for a capacity of 15,000 h. p. with high-pressure Pelton turbines, and will supply Innsbruck and its vicinity with electricity. 2300 w. Engr, Lond—March 23, 1906. No. 75909 A.

Isolated Plants.

Electrical Equipment of Wanamaker's New York Store. Illustrated description of this installation for lighting, motors, heating, ventilating and mechanical service. 2700 w. Elec Wld—March 31, 1906. No. 75887.

Installation and Maintenance of a Small Electric Light Plant. An illustrated description of the plant at Jordan, Minn., a town of 1200 inhabitants. 2500 w. Power—May, 1906. No. 76362 C.

The Central Station for the Armour Plants. Illustrated description of a plant for supplying power to a collection of factory buildings. 3500 w. Engr, U S A—April 2, 1906. No. 75889 C.

Municipal Plant.

A Municipal Steam Turbine Station at Columbus, Ohio. Illustrates and describes interesting details of the plant for street arc lighting. 2800 w. Eng Rec—March 31, 1906. No. 75882.

Parallel Operating.

Regulating Compound-wound Dynamos Operating in Parallel. Directions with diagrams. 1200 w. Power—April, 1906. No. 75856 C.

Power Houses

The Long Island City Power Station of the Pennsylvania Railroad Company's Extensions to New York and Long Island. Illustrated detailed description of the plant and its equipment. 9200 w. St. Ry Rev—April 15, 1906. No. 76061 C.

The Pennsylvania Railroad's Extension to New York and Long Island. An il-

lustrated article dealing principally with details of the Long Island City power station. 10000 w. Eng Rec—April 7, 1906. No. 75985.

The Pennsylvania Railroad's Extension to New York and Long Island—The Long Island City Power Station. Illustrated detailed description, dealing principally with the station and its equipment. 1200 w. St Ry Jour—April 7, 1906. No. 75990 C.

The Long Island City Power Station. Illustrated detailed description of the design and equipment. 4200 w. Ir Age—April 5, 1906. Serial. 1st part. No. 75920.

The Long Island Power Station of the Pennsylvania, New York and Long Island Railroad. Illustrated, detailed description of the station which is to furnish the very large amount of power needed by the Long Island Railroad, the new lines which are to tunnel under the East River, and the Atlantic Ave. improvement. 3000 w. Power—April, 1906. No. 75855 C.

The Nassau (L. I.)Light and Power Company. An illustrated account of the development of a company covering the territory of a large portion of the central part of Long Island, involving distribution to a large number of small villages. 3800 w. Elec Wld—April 7, 1906. No. 76087.

The New Lighting and Power Station at Glenwood. Illustrated description of this new station of the Nassau Light & Power Co., which will supply electricity to the central part of Long Island. 6500 w. Eng Rec—April 14, 1906. No. 76314.

Records.

The Keeping of Consumers' Records in Electric Supply Undertakings. Describes a system found very successful. 1000 w. Elec Rev, Lond—March 23, 1906. No. 75900 A.

Re-Winding.

Rewinding Dynamo Electrical Machinery. Norman G. Meade. Explains, with the aid of diagrams, a method of repairing electrical machinery that can be adopted by manufacturing concerns having their own electric plants. Confined to direct-current machinery. 1600 w. Power—May, 1906. No. 76365 C.

Switchboards.

Switchboard Arrangement for Central Power Plants (Vereinigte Schaltung und Bedienung von Betriebsmaschinen in Elektrischen Zentralen). Karl Wertenson. Describing the arrangement at the municipal plant at Riga, in which the control of all the machinery is centralized at one switchboard. 2000 w. Zeitschr d Ver Deutscher Ing—April 14, 1906. No. 76209 D.

LIGHTING.

Frequency.

Lighting on 25 Cycles in Buffalo. H. B. Alverson. On the success with 25-cycle lighting with incandescent lamps, and some causes that affect the illumination. 1500 w. Elec Jour—April, 1906. No. 76356.

The Variation of Candle-power Due to Frequency. P. O. Keilholtz and B. Harrison Branch. Reports experiments performed to determine the variation in the intensity of illumination of any incandescent lamp on a 25-cycle alternating-current circuit. Also editorial. 3000 w. Elec Jour—April, 1906. No. 76355.

Lamps.

The Economical Life of Incandescent Lamps. Lancelot W. Wild. Aims to show the relation existing between the economical life of ordinary commercial carbon filament incandescent lamps and the price per unit for electrical energy. 600 w. Elec Rev, Lond—April 6, 1906 No. 76072 A.

Photometry.

See Electrical Engineering, Measurement.

Residence Lighting.

An Example of House Lighting Design. J. R. Cravath and V. R. Lansingh. Gives plan and designs for a house recently built in Pasadena, Cal., where excellent illumination with a minimum operating cost was desired. 1800 w. Elec Wld—April 7, 1906. No. 76089.

Waste.

Waste in Incandescent Electric Lighting. Refers to methods described in paper by George Wilkinson, and offers suggestions for lessening the waste. 2200 w. Elec Rev, Lond—April 13, 1906. No. 76144 A.

MEASUREMENT.

Meters.

Defective Connections for Three-Phase Meters (Falsche Drehstromzähler Schaltungen). F. Niethammer. A discussion of the importance of using correct connections of the voltage coils of double meters for three-phase currents in order to insure correct measurements. 1200 w. Elektrotech u Maschinenbau—March 18, 1906. No. 76252 D.

Photometry.

A Portable Selenium Photometer for Incandescent Lamps. Dr. Theo. Torda. Describes an apparatus based upon the action of the light on selenium, which alters its electric resistance with variations, of the intensity of light. 2800 w. Elect'n, Lond—April 13, 1906. No. 76193 A.

Experimental Researches in Photometry.

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(Untersuchungen auf dem Gebiete der Photometrie). Karl Satori. A study of the relation of spectroscopy to photometry, showing the importance of comparing lights of corresponding wave lengths. Discussion. 5000 w. Elektrotech u Maschinenbau—March 18, 1906. No. 76253 D.

The Measurement of Illumination (Beleuchtungsmessungen). F. Uppenborn. Discussing especially the methods used in the laboratory of the municipal electric station in Munich and the use of the Martens photometer. 1500 w. Elektrotech Zeitschr—April 12, 1906. No. 76258 B.

MOTORS.

Induction Motors.

Graphic Representation of Induction Motor Phenomena. A. S. M'Allister. Aims to show that the primary current cannot be accurately represented by any circle, but that the secondary current locus is a true circle. Also editorial. 3000 w. Elec Wld—April 21, 1906. No. 76185.

Starting Torque of Induction Motors. R. E. Hellmund. Deals with the predetermination of the commercial starting torque. Also editorial. 1800 w. Elec Wld—March 31, 1906. No. 75888.

The Separation of the Losses in Induction Motors. G. W. O. Howe. Reviews methods suggested by Benischke, and by Messrs. Bragstad and La Cour and the experiments of Herr Bache-Wüg. 1400 w. Elect'n, Lond—March 30, 1906. No. 76008 A.

Inter-Pole.

The Advantages of the Inter-Pole Design in Railway Motors. G. Herbert Condict. A statement of the advantages of this type of motor in direct-current-practice, illustrating graphically some features. 900 w. St Ry Jour—April 21, 1906. No. 76174 C.

Motor Standards.

Standard Conditions for the Use of Motors in Connection with Public Electric Stations (Normale Bedingungen für den Auschluss von Motoren au Oeffentliche Elektrizitätswerke). L. Schuler. A review of the proposed regulations of the German Electotechnical Association relating to the conditions under which electric motors may receive current from municipal lighting stations. 2500 w. Elektrotech Zeitschr—April 12, 1906. No. 76257 B.

Speed Control.

Speed Characteristics and the Control of Electric Motors. C. F. Scott. Mr. Scott's second paper treats of practical applications of alternating-current motors to the driving of machine tools; with numerous illustrations of working installations. 3000 w. Engineering Magazine—May, 1906. No. 76274 B.

The Adaptability of Variable Speed Motors. Explains the advantages of the plain variable speed motor. 1000 w. Elec Rev, Lond—March 30, 1906. No. 76005 A.

Wiring.

The Wiring and Maintenance of Shunt and Compound-Wound Motors. William Kavanagh. Considers the wiring and care of both types. Ill. 1000 w. Elec Wld—April 7, 1906. No. 76088.

TRANSMISSION.

Niagara.

The Niagara-Syracuse Transmission Line. Orrin E. Dunlap. An illustrated description of this long transmission line. 2500 w. Elec Wld—April 14, 1906. No. 76157.

Protective Devices.

Lightning Protection. Newton Harrison Explains the conditions that cause lightning, and discusses the means adopted to secure immunity from shock or fire. 1800 w. Cent Sta—April, 1906. No. 75998.

INDUSTRIAL ECONOMY

Canals.

The Law of Canals. J. H. Cockburn. A discussion of English law in regard to questions relating to canals. 2200 w. Col Guard—April 6, 1906. Serial. 1st part. No. 76077 A.

Coal Strike.

The Meaning of the Coal Strike in the United States. F. E. Saward. A review of the present actual conditions in the anthracite and bituminous coal fields of the United States and a discussion of the points at issue between the miners and operators in the spring of 1906. 3500 w. Engineering Magazine—May, 1906. No. 76278 B.

Commerce.

American Commercial Relations: A Coming International Problem. M. A. Oudin. A discussion of the rapidly rising importance of the American export trade and the necessity of adopting improved methods for its development. 4000 w. Engineering Magazine—May, 1906. No. 76271 B.

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Commercial Engineering.

Problems That Confront Engineering and Kindred Industries on the Pacific Coast. George W. Dickie. Read before the Engng Cong., Lewis & Clark Ex. Deals mostly with the commercial problems, stating the conditions to be met. 5000 w. Jour Assn of Engng Socs—Feb. 1906. No. 76115 C.

Education.

The College Shop. Dexter S. Kimball. Briefly explains the aim in manual training schools, trade schools, and engineering colleges, discussing the college shop in detail. Ills. 3800 w. Am Mach—Vol. 29, No. 16. No. 76125.

The Education of Mining and Metallurgical Engineers. Prof. John Bonsall Porter. Read before the Can. Min. Inst. Outlines the course of study which will give the best preparation possible. Many illustrations accompany this article. 3800 w. Can Min Rev—April, 1906. No. 76181 B.

The Successful Apprenticeship and Educational System of the General Electric Co., West Lynn, Mass. An address by M. W. Alexander, who developed the system, describing its features. 4200 w. Mach, N Y—April, 1906. No. 75879 C.

The Teaching of Metallurgy in College Laboratories, and a Description of the Equipment and Uses of the Metallurgical Laboratories at McGill. Dr. A. Stansfield. Considers the use and limitations of such teaching, and describes the equipment at McGill University. Ills. 4000 w. Can Min Rev—April, 1906. No. 76182 B.

Iron Industry.

The Iron and Steel Industries of the United States (L'Industrie Sidérurgique aux Etats Unis). G. Rivière. A statistical and descriptive review of the industry in America, with illustrations and plans of the principal plants. 18000 w. 3 plates. Mem Soc Ing Civ de France—Feb., 1906. No. 76237 G.

Labor.

The Condition of the German Working-man. Earl Dean Howard. Abstract of a chapter of the author's essay upon "The Cause and Extent of the Recent Industrial Progress of Germany." An interesting discussion of the factors other than wages which affect the condition. 6500 w. Ir & Coal Trds Rev—April 6, 1906. No. 76085 A.

Philippines.

Transportation Systems and Projects in the Philippines. L. W. Bennett. A handsomely illustrated account of the resources, needs, and special industrial, agricultural and commercial features of the islands. 3500 w. Engineering Magazine—May, 1906. No. 76273 B.

Piece-Work.

A Rational Method for the Introduction and Management of Piece-Work in Railroad Shops. William S. Cozad. Read before the New England R. R. Club. Describes the organization worked out for the Erie R. R. on the piece-work system. 2400 w. R R Gaz—April 13, 1906. No. 76048.

Rate Regulation.

President Stickney on Rate Regulation. Extract from a paper in the *Political Science Quarterly*, for March, 1906. Advises an interstate commerce investigation committee outlining the work it should undertake, before legislation is framed. 2500 w. R R Gaz—April 6, 1906. No. 75955.

The Hepburn Bill. Editorial discussion of this bill for rate regulation, pointing out the good and bad features. 2000 w. R R Gaz—April 27, 1906. No. 76377.

Works Management.

A History of the Introduction of a System of Shop Management. James M. Dodge. An account of the introduction of the Taylor system, and the results. Discussion. 3500 w. Am Soc of Mech Engrs, No. 094—May, 1906. No. 76111.

The Commercial Organization of Engineering Factories. Henry Spencer. The first of a series of articles describing the whole commercial routine of an engineering factory, especially the principles of organization. 3000 w. Engr, Lond—March 30, 1906. Serial. 1st part. No. 76015 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Contract Trials of the U. S. Battleship Virginia. Gives the dimensions, armament, and report of trials. 1500 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76349 H.

The Japanese Battleship Kashima. Illustration, with description of the vessel and its armament, and report of trials. Built in England. 2300 w. Engng—April 13, 1906. No. 76303 A.

The U. S. Battleship Louisiana. Illustration, with description and report of trials. 16000 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76350 H.

U. S. Battleship Rhode Island. Charles B. Edwards and Ralph L. Lovell. Illustration, with description and report of

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official trial. 4000 w. Jour Am Soc of Nav Engrs—Feb., 1906. 76344 H.

Bearings.

An Investigation of the Pressures upon the Main Bearings and Crank Pins of Marine Engines. Edward M. Bragg. Reports an investigation undertaken with the object of finding an approximate method for the determination of the loads to which the crank-shaft bearings of a proposed engine would be subjected. Diagrams. 6500 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76345 H.

Boilers.

See Mechanical Engineering, Steam Engineering.

Bulkhead Doors.

Official Tests of Electrically Operated Bulkhead Doors. A report of the official trials made by the United States Navy Department. Ills. 1800 w. Marine Engng—April, 1906. No. 75859 C.

Cable Steamer.

See Electrical Engineering, Communication.

Colonial Service.

Vessels for Colonial Service. Sir Edward J. Reed. Read before the Inst. of Naval Archts. On the construction of new vessels, and the renewal of details. Deals with a variety of types. Ills. 14000 w. Engng—April 6, 1906. No. 76082 A.

Cruisers.

French Armored Cruisers. J. Peltier. Gives particulars of the types built since 1898, with illustrations. 1500 w. Marine Engng—April, 1906. No. 75857 C.

Peruvian Cruiser, Almirante Grau. Brief description of this twin-screw protected cruiser for the Peruvian Navy. 1000 w. Engng—March 23, 1906. No. 75912 A.

Docks.

Large Floating Docks (Les Grands Docks Flottants). L. Piaud. A general description of the modern self-docking sectional floating dock with illustrations of recent examples, including the docks at Hamburg, Cavite, and Tsing-Tao. Two articles. 5000 w. Génie Civil—March 17, 24, 1906. No. 76212, each D.

Electric Installations.

Electricity on Atlantic Liners. Illustrated description of the installation on the twin-screw steamship Amerika, showing the many applications made of electricity. 2300 w. Engr, Lond—March 23, 1906. No. 75908 A.

Ferry Steamers.

American Train Ferry Steamers. Illustrates and describes types in service at San Francisco, New York, on the Great Lakes, and at other points. 1400 w. Engr, Lond—March 23, 1906. Serial. 1st part. No. 75907 A.

Gas Propulsion.

See Mechanical Engineering, Combustion Motors.

Liners.

The New Amsterdam, Latest Trans-Atlantic Liner, Reaches New York on Her Maiden Trip. Illustrated description of the new twin-screw steamship "New Amsterdam," of the Holland-America Line. 1800 w. Naut Gaz—April 19, 1906. No. 76160.

The Steamship Provence of the French Transatlantic Line (Le Paquebot "La Provence" de la Compagnie Générale Transatlantique). A. Dumas. With numerous illustrations of the latest addition to the French line. The displacement is 19,160 tons, and speed 21 knots. Serial. Part I. 1 plate. 2000 w. Génie Civil—April 7, 1906. No. 76219 D.

Motor Boats.

Motor Boats. Bernard B. Redwood. Discusses the possibilities of the internal combustion engine for marine propulsion. Discussion. Ills. 7800 w. Jour Soc of Arts—March 23, 1906. No. 75891 A.

100-Horse-Power Suction-Gas - Propelled Boat on the River Rhine. Illustrated description of the boat "Lotte," a flat-bottomed barge measuring 139 feet 6 inches in length. It has proved highly economical in operation. 1000 w. Sci Am—April 14, 1906. No. 76036.

The Design and Construction of High Speed Motor Boats. James A. Smith. Excerpts from a paper read before the Inst. of Nav. Archts. Considers model types of high-speed launches, rendered possible by the development in internal combustion motors. 2200 w. Auto Jour—April 14, 1906. No. 76190 A.

The Speed of Motor Boats and Their Rating for Racing Purposes. Linton Hope. Excerpts from a paper before the Inst. of Naval Archts. Shows the great increase of speed since the internal combustion engine has been used, shows the use of motor boat racing in giving data applicable to the design and construction of hulls, and discusses racing rules. 2200 w. Auto Jour—April 14, 1906. Serial. 1st part. No. 76191 A.

Naval Machinery.

Suggestions for the Care and Operation of Naval Machinery in the Engineer Department U. S. Navy. H. C. Dinger. The first of a series of articles describing the main features in connection with the care and operation of naval machinery. 13500 w. Jour Am Soc of Nav Engrs—Feb. 1906. Serial. 1st part. No. 76348 H.

Propulsion.

Remarks on Screw Propulsion. R. D. Gatewood. A brief summary and discussion of the results of the theories and experiments of Rankine, the Froudes (father and son), Taylor, Greenhill, and

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others. 2000 w. Pro U S Nav Inst—March, 1906. No. 76100 G.

Revenue Cutter.

A New Shallow Draft Revenue Cutter. Illustrates and describes a revenue cutter designed for use on Albemarle and Pamlico Sounds in North Carolina. 3500 w. Marine Engng—April, 1906. No. 75858 C.

Scouts.

The New Scouts. C. C. P. Fitz-Gerald. Read at the Inst. of Naval Archts. Illustrations and information concerning these vessels, with general opinions on scouting and a comparison with 1901 design. 2200 w. Engng—April 6, 1906. No. 76080 A.

Shipyards.

The Introduction of Cranes in Shipyards. Alexander Murray. Read before the Inst. of Naval Archts. Discusses improvements in shipyards and the results of efficient crane service, illustrating types introduced. 3200 w. Engng—April 13, 1906. No. 76302 A.

The Overhead Wire Cableway Applied to Shipbuilding. J. L. Twaddell. Read before the Inst. of Naval Archts. Principally an illustrated description of the system at the Jarrow Yard of Palmer's Shipbuilding and Iron Co., Ltd. 4000 w. Engng—April 13, 1906. No. 76306 A.

Steamboat.

Launch of New Steamboat Hendrick Hudson. An illustrated article giving an account of the launch and describing features of this vessel which will cost nearly a million of dollars. 3000 w. Naut Gaz—April 5, 1906. No. 75988.

Steamships.

New Twin-Screw Steamship Mooltan. Illustrated description of this mail steamer built for service between the East Indies and England. 1300 w. Naut Gaz—March 29, 1906. No. 75867.

Steam Turbines.

See Mechanical Engineering, Steam Engineering.

Transatlantic.

Transatlantic Lines and Steamships. Arthur J. Maginnis. Read before the Liverpool Engng Soc. A review of the past decade, and especially the advances of the last few years. 6000 w. Marine Rev—March 29, 1906. No. 75845.

Videttes.

High-Speed Vidette Pinnaces. G. Simpson. Illustrated description of videttes built for the Imperial Japanese Navy. 2000 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76346 H.

MECHANICAL ENGINEERING

AUTOMOBILES.

Cadillac.

The Four-Cylinder Cadillac—A New Vertical Model. An illustrated article giving a summary of the features of this 1906 model. 1200 w. Auto Jour—April 14, 1906. No. 76188 A.

Chainless.

The 14-22 H. P. Germain Chainless Car. Detailed description, with illustrations. 1500 w. Autocar—April 7, 1906. No. 76069 A.

Engines.

An 18 H. P. Six-Cylinder Rotary Petrol Engine. Illustrated detailed description of an interesting engine designed by F. Lamplough, for automobiles. 1600 w. Autocar—March 24, 1906. No. 75896 A.

Rating Petrol Engines by Cylinder Dimensions. Dugald Clerk. Read before the Auto. Club, England. Gives report of tests made, discussing results. 2000 w. Auto Jour—March 31, 1906. No. 76000 A.

The Rating of Motor Car Engines. Extracts from a lecture delivered by Prof. Hopkinson, of Cambridge University, to the members of the Midland Auto Club. Discusses the origin of horse-power, the factors, the source of power, inertia forces, piston speed, etc. 2500 w. Autocar—March 24, 1906. Serial. 1st part. No. 76001 A.

Gasoline Cars.

How to Operate a Gasoline Car. Edward T. Birdsall. Points on starting, running, controlling, hill-climbing etc., are discussed. 2700 w. Automobile—April 26, 1906. No. 76370.

Humber.

The Humber Petrol Cars. Illustrated descriptions of the four and six-cylinder models. 1200 w. Auto Jour—March 24, 1906. Serial. 1st part. No. 75894 A.

Iris.

The 25-30 and 35-40 H. P. Iris Cars. Illustrates and describes the frame, engine, carburetter, throttle valve, ignition system, change-speed gear, and other features of these British built cars. 2200 w. Autocar—April 14, 1906. No. 76187 A.

Live Axle.

The Hedgeland Solid Live-Axle. An illustrated description of a device for eliminating the differential-gear in cars (chain-driven as well as live-axle), which is being officially tested, and for which non-skidding properties are claimed. 2200 w. Auto Jour—April 14, 1906. No. 76189 A.

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Manufacture.

The Making of an Automobile. An illustrated article outlining the methods of an up-to-date automobile manutacturing establishment. 1600 w. Automobile —April 26, 1906. No. 76371.

Mechanical Plant.

Mechanical Plant in the Motor Mart of Boston. Howard S. Knowlton. Describes a building for the storage, repair and sale of motor vehicles, the power plant and mechanical equipment. Ills. 2500 w. Engr, U S A —April 16, 1906. No. 76127 C.

Omnibuses.

The Critchley-Norris Petrol 'Bus. Illustrates and describes the special features of this chain-driven vehicle. 1400 w. Auto Jour—March 24, 1906. Serial. 1st part. No. 75895 A.

The Field of the Electric Tramway and Motor Omnibus. E. Manville. Read before the Automobile Club. A comparison of the advantages and disadvantages of the two systems, and of the costs. 5000 w. Elec Engr, Lond—April 13, 1906. Serial. 1st part. 76192 A.

30 Horse Power Motor Omnibus. Illustrates and describes the chassis of a powerful vehicle for service in London. 1200 w. Engr, Lond—March 23, 1906. No. 75910 A.

Steam Wagon.

Motor Car Show at Islington. Illustrates and describes a five-ton steam wagon exhibited, with several features of interest. The boiler is of the top-fired locomotive pattern. Other steam vehicles are mentioned. 2500 w. Engr, Lond—March 30, 1906. No. 76018 A.

Suggestions.

Unsolved Problems in Auto Engineering. Suggestions from an address by R. E. B. Crompton in London, in regard to possible modifications in automobile construction. 4500 w. Automobile—April 12, 1906. No. 76044.

Touring Cars.

Factors Contributing to Comfort in Autos. Translated from the French of H. André in *La France Automobile.* Discusses the influence of the engine, diameter and nature of wheels and tires, and body suspension. 3500 w. Automobile—April 5, 1906. No. 75943.

COMBUSTION MOTORS.

Gas Engines.

Notes on the Design of Large Gas Engines with Special Reference to Railway Work. Arthur West. Remarks on engines suitable for important electric railway installations. Ills. 2300 w. Can Engr—April, 1906. No. 75922.

The Commercial Production of Nitric Acid in Connection with the Operation of Gas Engines. H. Diederichs. Reviews a lecture by Mr. Haeusser, before the Society of German Engineers, presenting the main points of this proposition, and discussing experimental investigations. 2000 w. Sib Jour of Engng—April, 1906. No. 76390 C.

Some Notes on Gas Engines for Electric Lighting. R. C. Dieppe. Gives some points gained from experience which may be of use in ordering gas engines for electric lighting plants. 2000 w. Elec Rev, Lond—March 30, 1906. No. 76006 A.

Gasoline Engines.

Heat Analysis of a Gasoline Engine. P. F. Walker. Describes a method worked out by the writer. 2000 w. Engr, U S A—April 2, 1906. Serial. 1st part. No. 75890 C.

Gas Power.

Gas Power Economics. F. E. Junge. Enlarged from an address delivered before the Am. Inst. of Elec. Engrs. Discusses methods and facts observed in Europe, comparing gas and steam driven Central Stations, and giving facts of interest to the iron and steel industry. 2800 w. Ir Age—April 26, 1906. Serial 1st part. No. 76312.

Gas Producer Plant for Electric Generating Stations. Wm. J. N. Sowter. Abstract of a paper and discussion before the Dublin Sec. of the Inst. of Elec. Engrs. Briefly considers bituminous producers, suction producers, gas engines, and their working, discussing their economy, etc. 4000 w. Elect'n. Lond—April 6, 1906. No. 76076 A.

Some Features of the Warren Gas Power Plant. J. R. Bibbins. Illustrated description of features in the gas engine equipment of the plant of the Warren & Jamestown Street Railway. 1800 w. Elec Jour—April, 1906. No. 76353.

"10 H. P. for an Hour for One Penny!" Abstracted from *Electrics.* Gives investigations made and a report of the trials of shops driven by suction gas plant, as compared with electricity. Considers suction gas expensive to install, of doubtful reliability, and troublesome to work. 2300 w. Elec Engr, Lond—March 23, 1906. No. 75897 A.

The Coming Power. E. R. Knowles. Presents information showing the gas engine producer system to be the cheapest in cost of any production known, and discusses its advantages. 2000 w. Elec Rev, N Y—April 21, 1906. No. 76159.

Gas Propulsion.

Gas Engines for Ship Propulsion. J. E. Thornycroft. Read before the Inst. of Naval Archts. Describes the working of a gas-engine in conjunction with a gas producer, considering the possible advantages and some of the difficulties, and gives details of a number of vessels fitted with them, which have shown satisfactory

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results. Ills. 4000 w. Engng—April 13, 1906. No. 76305 A.

Gas Turbines.

Notes on Prime Movers with Especial Reference to the Gas Turbine (Généralités sur les Moteurs et Spécialement les Turbines à Gaz). J. Deschamps. An examination of the application of the Carnot cycle to heat engines as in the Diesel motor, showing also the possibility of approximating this result in the gas turbine. 3000 w. Mem Soc Ing Civ de France—Feb., 1906. No. 76236 G.

The Gas Turbine (Les Turbines à Gaz). L. Sekutowicz. An exhaustive study of the theory of the gas turbine, with a discussion of the constructive features, and a review of the experimental work thus far done. 20,000 w. Mem Soc Ing Civ de France—Feb., 1906. No. 76235 G.

Ignition.

Ignition System for Gasoline Motors. Clarence B. Brokaw. From a lecture delivered before the Auto Club of America. Considers the make-and-break system, and the jump spark. 6000 w. Automobile—April 19, 1906. No. 76148.

Producer Gas.

Trials of Producer Gas Plants. R. E. Mathot. Calls attention to the manner the coal consumed in the generator should be measured, reporting tests made on producer-gas engines. 1200 w. Power —May, 1906. No. 76366 C.

Valves.

Functions of Valves in Four-Cycle Motors. Shows the arrangement and operation of the inlet and exhaust valves of a modern four-cycle gasoline motor. Ills. 2200 w. Automobile—April 19, 1906. No. 76147.

HEATING AND COOLING.

Economy.

Economy in Household Heating (Die Oekonomie der Häuslichen Heizung). Dr. E. J. Constam. Discussing especially the various stoves and heaters adapted for household use in Switzerland. 3500 w. Schweiz Bauzeitung—March 17, 1906. No. 76248 B.

Exhaust Steam.

A Distillery Power and Heating Equipment. Illustrated description of a plant in Baltimore, Md., which heats, by means of its exhaust steam, no less than 16 detached buildings. 800 w. Heat & Vent Mag—April, 1906. No. 76357.

Hot Water.

Hot Water Heating in a New York Apartment House. Illustrates and describes a gravity circulation hot-water radiation in a ten-story building. 2800 w. Met Work—April 21, 1906. No. 76141.

Refrigeration.

Mechanical Refrigeration and Its Future Development. Jos. H. Hart. A thermodynamic study of the principles of mechanical refrigeration, considering the steam engine as a reverse prototype of the compressor. 3500 w. Engineering Magazine—May, 1906. No. 76277 B.

Schoolhouse.

The Schoolhouse—Its Heating and Ventilation. Joseph A. Moore. Presents method proved by experience to give satisfactory results. Favors the downward system of ventilation. 2000 w. Heat and Vent Mag—April, 1906. Serial. 1st part. No. 76359.

Theater.

Mechanical Equipment of the New Amsterdam Theater, New York. Describes a system of upward ventilation. Ills. 1500 w. Heat & Vent Mag—April, 1906. No. 76358.

Ventilation.

Upward and Downward Ventilation. William J. Baldwin. Favors the upward system of ventilation. 2000 w. Heat & Vent Mag—April, 1906. No. 76360.

HYDRAULICS.

Governors.

Some Stepping Stones in the Development of a Modern Water-Wheel Governor. Mark A. Raplogle. Describes a mechanical governor and some of the principles that enter into its construction, showing the steps that led to the development. 5500 w. Am Soc Mech Engrs, No. 095-B—May, 1906. No. 76105.

Speed Regulation of Water-Power Plants. John Sturgess. Considers elements of design in water-wheels, and characteristics of governor action as obtained in the best practice of the present day. 3500 w. Ills. Am Soc of Mech Engrs, No. 095-D—May, 1906. No. 76107.

The Regulation of High-Pressure Water-Wheels for Power-Transmission Plants. George J. Henry, Jr. Discusses the various devices used for protection and regulation, their advantages and defects. Ills. 4000 w. Am Soc of Mech Engrs, No. 095-C—May 1, 1906. No. 76106.

Laboratory.

The Hydraulic Testing Laboratory of the Worcester Polytechnic Institute. Charles M. Allen. Illustrated detailed description of this plant, which furnishes facilities for a large variety of hydraulic experiments. 2300 w. Eng Rec—March 31, 1906. No. 75883.

The New Hydraulic Laboratory at the University of Wisconsin. D. W. Mead. Illustrated detailed description of this new laboratory and its equipment. 3000 w. Wis Engr—March, 1906. No. 76322 D.

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Pipe Conduit.

Designing the 18-Ft. Steel Pipe of the Ontario Power Company, Niagara Falls. Joseph Mayer. Deals with studies in connection with the design of this pipe, its protection against rust and its probable life; its resistance to deformation, its stability, etc. 7000 w. Eng News—April 26, 1906. No. 76339.

Pumping.

See Civil Engineering, Water Supply.

Pump Tests.

A New Method of Measuring Water in Pump Tests. E. H. Birney. Describes a plan adopted in testing a pump, under actual operating conditions, to determine if certain guarantees were fulfilled. Ills. 900 w. Power—May, 1906. No. 76364 C.

Recuperation.

The Recuperation of Waterfalls (La Recuperation des Chutes d'Eau). A. Bernoud. The injector action of the discharge of water through sluices is used to augment the effective head. The plant at Chèvres near Geneva, is described. Two articles. 4000 w. Bull Tech de la Suisse Romande—Feb. 10, March 25, 1906. No. 76264, each D.

Turbine Pumps.

Turbine Pumps with Balanced Impellers. Gives illustrations and test results of two turbine pumps. The main feature is the use of back-to-back impellers, supplemented by an arrangement of thrust-chambers. 1800 w. Eng News—April 5, 1906. No. 75949.

Turbines.

A 10,000 H. P. Single-Wheel Turbine at Snoqualmie Falls, Wash. Arthur Giesler. Information of interest and illustrated description of the largest turbine of its type ever built. 3000 w. Eng News—March 29, 1906. No. 75864.

Efficiency Tests of Turbine Water Wheels. William O. Webber. Records a series of consecutive tests under uniform conditions of four water wheels, with the same apparatus, and same observers, to determine the efficiency, and other points of operation. Ills. 2000 w. Am Soc of Mech Engrs, No. 088—May, 1906. No. 76109.

Theory and Computation for Turbines and Centrifugal Pumps (Theorie und Berechnung des Vollturbinen und Kreiselpumpen). Dr. K. Kobes. A review of the discussion of Dr. Lorenz showing the working method of constructing the bucket curves from the formulas. 1200 w. Zeitschr u Ver Deutscher Ing—April 14, 1906. No. 76210 D.

Turbine Design as Modified for Close Regulation. George A. Buvinger. An illustrated discussion of the types of gates now in use for regulation, explaining their action. 2700 w. Am Soc of Mech Engrs. No. 095 E—May, 1906. No. 76108.

Water Power.

The Monopoly of Hydraulic Power in Switzerland (Die Monopolisierung der Schweizerische Wasserkräfte). H. E. Gruner. An exhaustive discussion of the legal and industrial questions involved in the National control of hydraulic power in Switzerland, including the prohibition of the transmission of energy out of the country. Two articles. 6000 w. Schweiz Bauzeitung—March 24, 31, 1906. No. 76250 each B.

MACHINE WORKS AND FOUNDRIES.

Annealing.

The Automatic Annealing of Metals. Illustrates and Describes the Bates-Peard continuous annealing furnace for non-ferrous metals. 1200 w. Ir Age—April 5, 1906. No. 75919.

Boiler Repairs.

Repairing Locomotive and Other Types of Boilers. R. E. M'Namara. Deals with this subject, especially the repairing of water-tube boilers. 2500 w. Boiler Maker—April, 1906. Serial. 1st part. No. 75992.

Boring Mill.

Designing a Boring Mill. A. L. de Leeuw. A critical review of an article appearing in No. 10, of the present volume of this paper. 5500 w. Am Mach—Vol. 29. No. 15. No. 76032.

Castings.

A Crooked Molding Machine Job. F. W. Hall. Describes work on a Paxson-Hall molding machine which had a very crooked pattern. Ills. 3000 w. Am Mach—Vol. 29. No. 17. No. 76333.

Open-Hearth Steel Casting. W. M. Carr. Discusses the manipulation of heats in acid practice. 2300 w. Foundry—April, 1906. No. 75937.

Cold Working.

Practical Notes on Wire Drawing and Cold Rolling (Aus des Praxis der Eisen Zieherei und Kaltwalzerei). Ernst Rolf. Data concerning the behaviour of annealed and unannealed metal in wire-drawing and other cold-working processes. 1800 w. Stahl u Eisen—March 15, 1906. No. 76227 D.

Cupolas.

Recent Examples of Cupola Construction. (Neue Kupolofenanlage). Fr. Greiner. With plans and elevations of cupola construction in recent German foundries, including data as to methods of operation, and performance. 4000 w. Stahl u Eisen—April 1, 1906. No. 76232 D.

Cutters.

Milling Cutters. An illustrated article considering types of plain milling cutters and of side milling cutters. 2500 w. Mach, N Y—April, 1906. No. 75878 C.

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Factory Equipment.

The New Mechanical Equipment at the Joseph Campbell Factory, Camden, N. J. Describes a factory for the manufacturers of food stuffs, said to be a model in mechanical equipment, cleanliness, and the elimination of manual handling of all materials. Ills. 3500 w. Eng Rec—April 21, 1906. No. 76328.

Forging.

Forging at the Collinwood Shops. Gives photographs of some of the articles which are being made in these shops of the L. S. & M. S. R. R., with descriptive notes. 1300 w. Am Engr & R R Jour—April, 1906. No. 75852 C.

Foundries.

A Modern Steel Foundry of the Square Type. Illustrated description of the Baldt Steel Co.'s foundry, at New Castle, Del. 2000 w. Ir Age—April 5, 1906. No. 75918.

Foundry Costs. R. W. McDowell. Describes a system intended to meet the requirements of the general foundry, giving forms used for reports. 5500 w. Ir Trd Rev—April 5, 1906. No. 75941.

Modern Foundry Construction. David Townsend. Read before the Philadelphia Foundry Foremen. Considers the essentials of a thoroughly modern shop. 1700 w. Ir Trd Rev—April 12, 1906. No. 76045.

South Altoona Foundries. Begins an illustrated description of the extensive new plant at South Altoona. The present article describes the wheel foundry. 2500 w. Am Engr & R R Jour—April, 1906. Serial. 1st part. No. 75849 C.

The Manufacturers' Foundry Co., Waterbury, Conn. Illustrates and describes a plant for the manufacture of intricate castings. 1800 w. Ir Trd Rev—April 19, 1906. No. 76145.

Hacksaws.

Testing Hacksaws. H. L. Whittemore. An account of the methods used in making the test, with diagrams. 1300 w. Am Mach—Vol. 29, No. 17. No. 76332.

Joints.

Design of a Riveted Joint. Franklin H. Smith. Gives formulas and explanatory notes. 1500 w. Mach, N Y—April, 1906. No. 75877 C.

Lifting Magnets.

Traveling Cranes with Electromagnets for Handling Bar Iron (Laufkran mit Elektromagneten zum Verladen von Stabeisen). Illustrated description of a crane by the Augsburg-Nürnberg Company, showing the use of magnets for handling rolled structural material. 1000 w. Stahl u Eisen—April 1, 1906. No. 76231 D.

Machine Screws.

Report of the Committee on Standard Proportions for Machine Screws, American Society of Mechanical Engineers. Full report, with 14 tables. 3500 w. Am Soc of Mech Engrs, No 085—May, 1906. No. 76112 C.

Metal Cleaning.

Notes on the Cleaning of Work by Means of the Electric Current. H. S. Coleman. Read before the Faraday Society. Reports experiments made, and the results, with cleaning iron and brass articles preparatory to nickel-plating them. 800 w. Electn, Lond—April 13, 1906. No. 76195 A.

Patterns.

Patterns for Heavy Engine Bed. H. J. McCaslin. An illustrated article discussing the different ways a pattern of this nature can be constructed. 4800 w. Foundry—April, 1906. No. 75938.

Portable Tools.

Portable Electric Tools and Their Industrial Application. Andrew Stewart. Considers points in design, and discusses breast drills, large portable tools, magnetic drilling pillars, and the efficiency of small electric tools. Ills. 2400 w. Elect'n, Lond—March 30, 1906. No. 76009 A.

Punching.

Automatic Multiple Punching Machine. A machine for punching the sheets and angles of structural iron work is illustrated and described. 2200 w. Am Mach—Vol. 29, No. 15. No. 76031.

Rolling Mills.

Methods of Driving Rolling Mills. (Antriebsarten von Walzenstrassen). Franz Gerkrath. A comparison of the relative advantages of steam, gas power, and electricity for driving rolling mill machinery. 3000 w. Stahl u Eisen—April 15, 1906. No. 76246 D.

Shops.

Osborn's File and Twist Drill Factories, at Sheffield, England. I. William Chubb. Illustrated detailed description of these plants and their equipment. 4000 w. Am Mach—Vol. 29. No. 14. No. 75944.

Works and Methods of Alfred Herbert, Ltd., Coventry, England. I. W. Chubb. An illustrated article giving information of interest in regard to the methods of these English tool-makers. 3200 w. Am Mach—Vol. 29. No. 15. Serial. 1st part. No. 76033.

Stock Keeping

A Stock-Keeping System for Raw and Finished Stores. F. W. Jessop. With illustrations of store rooms, and a detailed account of the method and system used by the Electric Controller and Supply Company. 3000 w. Engineering Magazine—May, 1906. No. 76275 B.

Time Card.

A Comprehensive Time Card. E. T. Elbourne. Gives a type of card for use with mechanical recorders explaining the advantages. 1400 w. Am Mach—Vol. 29. No. 17. No. 76335.

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Tools.

The Development of Machine Tools (Zur Entwicklungsgeschichte der Werkzeugmaschinen). Hermann Fischer. A historical review of the development of modern machine tools, with especial reference to the various forms of milling machines. 3000 w. Zeitschr d Ver Deutscher Ing—March 31, 1906. No. 76202 D.

Valves.

Globe Valve Standards. A. H. Nourse. Gives tables for low-pressure and heavy-pressure valves and handwheels as adopted by the large shipbuilding firms. Ills. 1500 w. Am Mach—Vol. 29. No. 13. No. 75862.

Variable Speed.

List of Cone and Gear Ratios for Variable Speed Drives. W. Owen. Gives tables, with explanation. 1200 w. Am Mach—Vol. 29. No. 17. No. 76334.

MATERIALS OF CONSTRUCTION.

Cast Iron.

Malleable Cast-Iron. Charles H. Day. Reviews the development, especially in the United States, since 1826, and describes the present process of manufacture. 3800 w. Am Mach—Vol. 29, No. 14. No. 75945.

The Constitution of Cast Iron (Ueber die Konstitution des Roheisens) P. Goerens. A metallographical study of the physical structure of cast iron, with reproductions of microphotographs. 4000 w. Stahl u Eisen—April 1, 1906. No. 76230 D.

High Temperatures.

Strength of Mild and Cast Steel at High Temperatures. Reviews the results obtained in a series of tests made by Prof. C. Bach, of Stuttgart. 2000 w. Engng—March 30, 1906. No. 76013 A.

Rivets.

The Resistance of Rivets Placed Hot (Résistance des Rivets après Mis en Place à Chaud) E. Simonot. A record of experimental tests showing the increase in the strength of rivets over that of the original bar when the rivets are used hot. 1200 w. Génie Civil—April 7, 1906. No. 76221 D.

Steel.

The Range in Tensile Properties of a Low Carbon Steel. James E. Howard. Reports tests made at the Watertown Arsenal showing a wide range in tensile strength due to methods of treatment. 800 w. Ir Age—April 26, 1906. No. 76313.

Tool Steel.

A Defective Bar of Tool Steel. C. E. Carson. A study of the cause for the failure of a finished tool from a bar of steel, showing that the steel did not receive sufficient work in drawing the ingot to render the finished bar sound. Ills. 600 w. Ir and St Mag—April, 1906. No. 76039 D.

High-Speed Steel in the Factory. O. M. Becker. Mr. Becker's fifth paper deals especially with the range and adaptability of alloy-steel tools, showing them to be as well adapted for finishing cuts as for roughing. 4500 w. Engineering Magazine—May, 1906. No. 76276 B.

Tubes.

Collapsing Pressures of Bessemer Steel Lap-Welded Tubes Three to Ten Inches in Diameter. Reid T. Stewart. Reports a research undertaken to supply reliable information on the behavior of modern wrought tubes when subjected to fluid collapsing pressure. Ills. 16200 w. Am Soc of Mech Engrs, No. 091—May, 1906. No. 76101 E.

Vaults.

Armor Plate—The Last Answer of the Banker to the Burglar. Traces the development of the use of special material in vault construction, describing the latest vaults, consisting of face-hardened, Harveyized plates from 5 to 16 inches in thickness, so accurately dove-tailed and locked together as to render the construction seemingly proof against any attack. 2700 w. Sci Am—April 21, 1906. No. 76135.

Waterproofing.

Practical Methods of Waterproofing and Fireproofing. Dr. Koller. Gives methods for making textile fabrics and pasteboard incombustible. 1000 w. Sci Am Sup—April 21, 1906. No. 76137.

MEASUREMENT.

Blows.

Effect of a Blow. Alexander W. Moseley and John Lord Bacon. A report of tests made to measure what a blow does to the piece struck. 900 w. Am Soc of Mech Engrs, No. 096—May, 1906. No. 76104.

Centrifugal Stresses.

The Stresses in Rotating Discs of Varying Thickness (Der Spannungszustand in Rotierenden Schreiben Veränderlicher Breite) M. Grübler. A mathematical investigation of the stresses produced in discs operated at high rotative speeds, with especial reference to the wheel of the de Laval steam turbine. 1800 w. Zeitschr d Ver Deutscher Ing—April 7, 1906. No. 76207 D.

Liquids.

A New Liquid Measuring Apparatus. George B. Willcox. An automatic device for measuring the brine flowing from a salt well into a salt works. The volume of the brine is determined by its weight. 1500 w. Am Soc Mech Engrs—No. 093. May, 1903. No. 76102.

Metric System.

The Metric System. A review of the recent movement in regard to the adop-

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tion of this system in the United States. 3300 w. Am Mach—Vol. 29. No. 15. No. 76035.

The Proposal to Force the Use of the Metric System. H. H. Suplee. A call for continued united action against the enactment of any legislation compelling the enforced use of the metric system of weights and measures, either in the Government service or in private industries, urging that the present freedom of action be continued. 2500 w. Engineering Magazine—May, 1906. No. 76272 B.

Micrometer.

An Electric Micrometer for Measuring the Seventy-Millionth Part of an Inch. Illustrated description of a machine designed by Dr. P. E. Shaw, of England, which is of great importance to scientific investigators. 2500 w. Sci Am Sup—April 7, 1906. No. 75933.

Pyrometer.

A Low Resistance Thermo-Electric Pyrometer and Compensator. Prof. William H. Bristol. Describes a thermo-electric pyrometer adapted for commercial and every day shop use. Also discussion. Ills. 12000 w. Am Soc of Mech Engrs, No. 090—May, 1906. No. 76110 C.

Screws.

Methods of Correcting Inaccuracies of Screw Threads. Illustrates and describes a method applicable to measuring apparatus, dividing machines, and other instruments of precision recently patented by J. E. Storey. 700 w. Mech Engr—April 14, 1906. No. 76196 A.

Seismographs.

Feeling the Earth's Pulse. Reviews some of the theories advanced to explain earthquakes, and gives illustrated descriptions of some of the recording instruments for measuring the disturbance. 4000 w. Sci Am—April 28, 1906. No. 76380.

Seismograph Record of the San Francisco Earthquake. Waldon Fawcett. Describes and illustrates the seismograph in the United States Weather Bureau observatory at Washington, D. C., and its recording of earthquakes. 1000 w. Elec Rev, N Y—April 28, 1906. No. 76395.

Torsion.

Tests on the Torsional Resistance of Bodies of Trapezoidal and Triangular Section (Versuche über die Drehungfestigkeit von Körpern mit Trapezförnigem und Drieckigem Querschnitt). C. Bach. Data and results of torsion tests upon prisms of various sections showing the relation of torsional and tensile strength. 1500 w. Zeitschr d Ver Deutscher Ing—March 31, 1906. No. 76203 D.

Vibrations.

The Sabouret Apparatus for Testing the Vibrations of Rolling-Stock. Illustrated description of an apparatus for recording the vibrations and oscillations of railway rolling-stock. 1500 w. Engng—March 23, 1906. No. 75911 A.

POWER AND TRANSMISSION.

Bearings.

See Marine and Naval Engineering.

Compressed Air.

Motor-Driven Air-Compressor. Illustrates and describes two air-compressors constructed by Messrs. Reavell and Co., Ltd. One to work an air-lift pump; the other to charge the air-reservoirs used in starting the Diesel oil-engine. 1300 w. Engng—April 13, 1906. No. 76301 A.

The Bursting of Metal Chambers Under Internal Air Pressure. L. H. Chandler. Information compiled from records of the Bureau of Ordnance which is applicable to other than torpedo-flasks. Ills. 2800 w. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76347 H.

Vertical Compound Two-Crank Inter-Cooling Air-Compressor. Detailed drawings, with description of two powerful air-compressors, each driven by a 400 h. p. gas engine. They supply air for various pneumatic tools, and also operate hammers in a smithy and forge. 1500 w. Engng—April 6, 1906. No. 76081 A.

Conveyors.

Cable Conveyors in Mining and Workshop service. (Schwebetransporte in Berg und Hüttenbetrieben). G. Dieterich. A fully illustrated description of the increasing use of conveyors and cableways in mining and manufacturing industries. Serial. Part I. 4000 w. Stahl u Eisen—April 1, 1906. No. 76229 D.

Mail Conveying Apparatus at the New Chicago Post Office Building. Illustrated detailed description of a very complete equipment for the handling of mail. 1500 w. Eng News—April 5, 1906. No. 75950.

Cranes.

Some German Electrically-Operated Cranes. Dr. Alfred Gradenwitz. Illustrates and describes some typical cranes, the electrical part of which was designed by the Siemens-Schuckert works. 1200 w. Sci Am Sup—April 28, 1906. No. 76381.

Rope Drives.

Endless Wire-Rope Drives. William Hewett. A study of the devices used and means of obtaining the best results. Ills. 3000 w. Stevens Ind—April, 1906. No. 76098 D.

Speed.

An Instantaneous Positive Speed Variator. H. F. Noyes. Illustrates a device designed for a small horizontal drilling and boring machine. 700 w. Am Mach—Vol. 29. No. 16. No. 76126.

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STEAM ENGINEERING.

Boilers.

Boiler Incrustation. M. Fletcher. Read before the British Columbia Assn. of Sta. Engrs. Discusses scale and the remedies, corrosion, etc. 1500 w. Engr, U S A—April 16, 1906. No. 76128 C.

Condensation.

Experiments on Surface Condensation. James Alexander Smith. An experimental study of the influence of the presence of air in small quantities upon the surface condensation of low-pressure steam. 7000 w. Engng—March 23, 1906. No. 75913 A.

Surface Condensers (Ueber Oberflächenkondensatoren) G. Hagemann. Developing formulas and diagrams for the proportions of condensers and air pumps for the maintenance of a determinate vacuum, in condensing a given volume of steam. 1000 w. 1 plate. Glückauf—March 24, 1906. No. 76239 D.

The Efficiency of Surface Condensers. Prof. R. L. Weighton. Read before the Inst. of Nav. Archts. Gives results from a very extensive series of trials which were of such a character as was thought might prove useful in the designing and proportioning of condensers generally. Ills. 3000 w. Engng—April 13, 1903. Serial. 1st part. No. 76304 A.

Engines.

A Heated Piston Engine. Charles R. King. Illustrated description of an engine built in Belgium and exhibited at Liége International Exhibition, explaining the objects of the steam distribution. 2000 w. Mach, N Y—April, 1906. No. 75876 C.

Erection.

Suggestions for Erecting Engines. Sterling H. Bunnell. General suggestions, with points on setting templates, indicating, adjusting the governor, etc. 2800 w. Power—May, 1906. No. 76367 C.

Feed Water.

Separation of Oil from Feed Water. J. H. Harwood. Discusses methods of treatment for eliminating the emulsified oil from the feed water. 2000 w. Elec Rev, Lond—April 13, 1906. No. 76143 A.

Firing.

Modern Practice for Firing Water Tube Boilers in Large Vessels. H. C. Dinger. Considers the proper conditions of firing, explaining system. 1800 w. Marine Engng—April, 1906. No. 75860 C.

Fuel Testing.

Coal Testing. John Holliday. Abstract from a paper read before the Dublin Sec. of the Inst. of Elec. Engrs. Discusses briefly the various methods of testing and a number of the instruments devised for making tests, and properties affecting the value of coal. 4500 w. Col Guard—April 13, 1906. No. 76197 A.

Pipes.

A Dangerous Steam Pipe. W. H. Wakeman. An arrangement for a large and small boiler in a battery for supplying steam to run an engine is shown, and its danger explained. 500 w. Power—May, 1906. No. 76363 C.

Smoke.

The Prevention of Smoke. Albert A. Cary. Condensed from an address before the N. Y. Sec. of the Soc. of Chem. Ind. Gives suggestions for preventing smoke, discussing the required intelligence in the boiler room, the design of grate, and the design of the furnace. 4000 w. Eng Rec—April 21, 1906. No. 76329.

Steam Consumption.

Steam Consumption of Winding Engines. Reports a trial of an isolated hoisting plant at the Ferriera mine, South Africa, made to determine whether the winding engine was subject to greater condensation losses than the ordinary continuous running engine, and also to discover what economy was effected by the use of trip valves. 3000 w. Engr, Lond—April 13, 1906. No. 76308 A.

Turbines.

Launch of the First American Built Turbine Steamship. An illustrated account of the launch of the "Governor Cobb," at Chester, with information concerning other turbines building. 1800 w. Naut Gaz—April 26, 1906. No. 76388.

Progress Made in the Application of the Parsons Turbine to Marine Propulsion. R. J. Walker. Briefly outlines the development of the turbine as an engine now used extensively for generating electricity and other uses, especially discussing its application to marine propulsion. 5500 w. Marine Rev—April 26, 1906. No. 76387.

Tests of a Curtis Marine Turbine. W. G. Diman. Describes the turbine and reports tests made in Brooklyn, N. Y. to determine the amount of steam used per brake horsepower at different revolutions per minute, and with steam varying in quality from saturated to about 50° F., superheat. 3000 w. Tables and diagrams. Jour Am Soc of Nav Engrs—Feb., 1906. No. 76351 H.

The Application of Steam Turbines to the Propulsion of Vessels (L'Application des Turbines à Vapeur a la Propulsion des Navires). G. Hart. A very complete review of the applications of turbines of various types to steamships with tabulated details of 22 turbine-propelled boats of all classes. 15000 w. 2 plates. Mem Soc Ing Civ de France—Jan. 1906. No. 76234 G.

The History and Development of the Steam Turbine. Harry Y. Haden. The present number reviews the history of

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the steam turbine from its first conception. Later article will describe the various types in service at present. Ills. 1700 w. Jour of Elec—April, 1906. Serial. 1st part. No. 75999 C.

The Utilization of Exhaust Steam in the Low-Pressure Turbine in Mining Plants (Verwertung des Abdampfes in Niederdruck-Turbinen-Anlagen auf Bergwerken). H. Hundt. Illustrated description of various installations of the Rateau steam accumulator for regulating the flow of exhaust steam for use with a low pressure steam turbine. 4000 w. Glückauf—March 17, 1906. No. 76238 D.

Valve Gears.

Strength and Resistance Conditions in Marine Valve Gears (Kraft und Festigkeits-Verhältuisse bei Schiffsmaschinen Steuerungen). Arthur Pröll. An examination of the link motion and of various radial valve gears, showing the frictional and inertia resistances, and the consequent proportions of the various members. Serial. Part 1. 3000 w. Schiffbau —April 11, 1906. No. 76262 D.

MISCELLANY.

Aeronautics.

How to Make a Gliding Machine. Livingston Wright and Gordon Johnson. Directions with working drawings. 1000 w. Sci Am Sup—April 28, 1906. No. 76384.

The Perfecting of the Aeroplane Flying Machine. Livingston Wright. Discusses the system of control worked out by the Wright brothers, and briefly reviews the work of other investigators. 1400 w. Sci Am Sup—April 7, 1906. No. 75932.

The Wright Aeroplane and Its Performances. An illustrated article on the success of the Wright brothers with their gliding machine in its improved form, with reports from eye-witnesses of the performance. 2000 w. Sci Am—April 7, 1906. No. 75927.

The Wright Brothers Flying Machine and What It Has Accomplished. A communication from Messrs. Orville and Wilbur Wright, to the Aero Club of America, giving details of the development of their motor-driven aeroplane. Also a letter to the Aeronautical Society of Gt. Britain and a short account of Santos Dumont's helicoptere. 2200 w. Sci Am Sup—April 7, 1906. No. 75931.

Drying.

The Art of Drying. George Wetmore Colles. Discusses its application to manufacturing processes, the systems, the types of dryers, etc. 3800 w. Stevens Ind—April, 1906. No. 76099 D.

MINING AND METALLURGY

COAL AND COKE.

Bituminous.

Great Lakes Coal Company. John Leggett Pultz. Illustrates and describes mines at Kaylor, near Pittsburg, which are large producers of bituminous coal. 1300 w. Eng & Min Jour—April 7, 1906. No. 75994.

Briquettes.

Briquetting of Fuels and Minerals G. J. Mashek. Illustrated description of the Zwoyer Fuel Company's process and the New Jersey Briquetting Company's plant. 1600 w. Ir Age—April 19, 1906. No. 76097.

Some Notes on Fuel Briquetting in America. Clarence M. Barber. Read before the Detroit Engng. Soc. Considers the materials used, methods of manufacture, presses, etc. 3000 w. Sci Am Sup —April 7, 1906. No. 75929.

China.

The Coal Fields of China. L. Ramakers. Information concerning the different fields and their characteristics, costs of mining, transportation, etc. 1700 w. Mines & Min—April, 1906. No. 75970 C.

The Hsüan Hua Coal Fields, China Noah Fields Drake. Maps and descriptions of three coal beds and the mines. 3500 w. Min Mag—April, 1906. No. 76042 C.

Classification.

The Classification of Coals. Dr. Persifor Frazer's contribution to the discussion of the paper by Marius R. Campbell. 2700 w. Bul Am Inst of Min Engrs—March, 1906. No. 76121.

Coal Fields.

Coal-Field Exploration. Thomas W. Keighley. Read before the Coal Min. Inst. of America. Describes methods of examination and sampling and the equipment needed by a coal expert. 2200 w. Mines & Min—April, 1906. No. 75972 C.

Coal Handling.

Coal Handling in the Chicago Subway. An illustrated description of the arrangements that have been made for the delivery of coal through the freight tunnels. 2300 w. Eng Rec—March 31, 1906. No. 75881.

Coal Supplies.

Coal Conservation, Power, Transmission, and Smoke Prevention. Arthur J. Martin. Considers the probable duration of England's coal supplies, the wastefulness of present methods, possible economics, electrical and gas transmission,

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etc. General discussion. 14000 w. Jour Soc of Arts—March 30, 1906. No. 75962 A.

Coke.

By-Product Coke Oven Plant at Camden, N. J. C. G. Atwater. Outlines the plan and construction of the original plant at Camden, N. J., and gives an illustrated detailed description of recent additions. 4800 w. Pro Age—April 2, 1906. No. 75866.

Colliery Equipment.

The Equipment of a Modern Colliery. F. W. Hardwick. Lecture before the Nat. Assn. of Colliery Mgrs. Discusses the choice of site, size of shafts, surface plant, sinking plant, winding engines, etc. Diagrams. 12000 w. Ir & Coal Trds Rev—April 6, 1906. No. 76086 A.

Electrical Equipment.

Electrical Equipment of the Aberdare Collieries of the Powell Duffryn Company. C. P. Sparks. Illustrated description of the equipment of this group of collieries, 20 miles north-west of Cardiff. 2000 w. Col Guard—March 30, 1906. Serial. 1st part. No. 76011 A.

Indian Territory.

Coal Mining in the Indian Territory. W. R. Crane. Describes mining methods where the coal and associated strata are more or less disturbed, and faults and folds, weak roof, much gas, and considerable water must be contended with. Ills. 2800 w. Eng & Min Jour—April 7, 1906. No. 75996.

Lignite.

Simpson Mine. E. D. Rust. Illustrated description of a large and well equipped lignite mine at Lafayette, near Denver, Colo. 2000 w. Mines & Min—April, 1906. No. 75963 C.

Rescue Appliances.

Rescue Appliances in Collieries. Gives illustrations of types of safety appliances, with descriptive notes, and information concerning experiments made in England. 2200 w. Col Guard—March 30, 1906. No. 76012 A.

The Fleuss-Davis Self-Contained Breathing Apparatus. Illustrated description of this recently improved apparatus. The principle is the regeneration of exhaled breath in a special reservoir carried by the wearer, by passing it through caustic soda and simultaneously renewing the supply of oxygen. 1500 w. Engng—April 13, 1906. No. 76300 A.

Sprinkling Plant.

Safety Arrangements for the Prevention of Colliery Fires and Explosions of Fire-Damp in German Coal Mines. Illustrates and describes one of the sprinkling plants used in the Westphalian coal mines. 900 w. Ir & Coal Trds Rev—March 23, 1906. No. 75915 A.

COPPER.

Alaska.

The Copper River District. L. A. Levensaler. Describes the copper deposits and the mines of this district. Gold, silver and other metals are associated. 2000 w. Cal Jour of Tech—Feb., 1906. No. 75961 C.

Assay.

The Quincy Mine Assay Office. C. W. Macdougall. Describes in detail the methods of determining the percentage of copper in waste sands, and other mineral deposits. 2000 w. Eng & Min Jour—April 7, 1906. Serial. 1st part. No. 75995.

Lake Superior.

Copper Mining on Lake Superior. J. Parke Channing. An illustrated account of recent development. 2000 w. Min & Sci Pr—March 24, 1906. No. 75847.

On the Ancient Copper Mines of Lake Superior. Alvinus Brown Wood. Description of an ancient pit on the Quincy mine location. 3300 w. Bul Am Inst of Min Engrs—March, 1906. No. 76120.

Mexico.

Growth of the Copper Industry in Mexico. Information concerning the mines, production, etc., showing Mexico to be the second largest of the world's producers. 1000 w. Min Rept—April 12, 1906. No. 76058.

Mount Morgan.

The Mount Morgan Mine. An illustrated description of recently completed copper treatment works at this mine in Queensland. 3000 w. Queens Gov Min Jour—Feb. 15, 1906. No. 75892 B.

New South Wales.

Great Cobar Copper Mine (N. S. W.). C. H. Cropper. Read before the Sydney Min. Engng. Soc. Describes and illustrates the working and timbering the stopes. 1700 w. Aust Min Stand—March 14, 1906. No. 76092 B.

Secondary Enrichment.

The Secondary Enrichment of Copper-Iron Sulphides. Thomas T. Read. Reviews the opinions advanced by various writers, and reports results of experimental work made to imitate natural conditions. 2500 w. Bul Am Inst of Min Engrs—March, 1906. No. 76122.

Smelting.

Estimation of Copper by Titration with Potassium Cyanide. Describes this method and some of its working details, as used in the laboratory of one of the largest Montana smelters. 1500 w. Eng & Min Jour—April 21,1906. No. 76162.

The Arizona Smelting Company's Plant in Yavapai County, Arizona. Illustrates and describes a plant comprising both copper and lead smelting works, and a concentrating plant of 400 tons capacity. 2400 w. Min Rept—March 29, 1906. No. 75869.

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Virginia.

The Virginia Copper Deposits. Walter Harvey Weed and Thomas Leonard Watson. Gives the results of an examination of these deposits, and a microscopic study of the rocks and ores. Ills. 6000 w. Ec Geol—Feb., 1906. No. 75840 D.

GOLD AND SILVER.

Alaska.

Recent Publications on Alaska and Yukon Territory. Alfred Hulse Brooks. A discussion of the literature dealing with this region, that has appeared during the past six months. The metalliferous deposits are first discussed; followed by a brief summary of the literature on the coal fields. 6500 w. Ec Geol—Feb., 1906. No. 75842 D.

Arizona.

Revival of Gold Mining in the Clifton-Morenci, Arizona District. This district in 1905 ranked second among the copper producing sections of the territory, and now a number of the properties are producing gold. Reports developments. 2200 w. Min Rept—April 19, 1906. No. 76175.

Assaying

The Assay of Cyanide Solutions. William Magenau. Describes a method for rapid determination of gold in cyanide solutions; also gives a summary of other methods. 2800 w. Min & Sci Pr—April 14, 1906. No. 76179.

British Columbia.

Mining and Milling at Ymir. D'Arcy Weatherbe. Describes deposits of gold and silver ore, the method of mining, and the treatment of the ore. 1200 w. Min & Sci Pr—March 24, 1906. No. 75848.

The Le Roi, Centre Star, and War Eagle Mines. D'Arcy Weatherbe. Describes these mines in British Columbia and their development. Gold, silver and copper. 2000 w. Min & Sci Pr—March 31, 1906. No. 75975.

Windy Arm Mineral Locations. W. F. Robertson. A report of mineral discoveries near the boundary line between British Columbia and Yukon Territory. Astonishingly high assays are reported, running as high as 800 oz. in silver, and $20 in gold to the ton. Map and Ills. 2500 w. Eng & Min Jour—April 14, 1906. No. 76055.

California.

The Central Mill of the North Star Mines Company. A. D. Foote. Illustrations with description of this fine new stamp mill at Grass Valley, Cal., and a statement concerning some features which have proved undesirable. 1000 w. Min & Sci Pr—April 7, 1906. No. 76060.

Cyanide.

The Cyanide process for Gold and Silver Ores. M. B. Parker. In the *Bul. of the International Miners' Assn.* Discusses its application to ores to which it was formerly considered unsuited. 2400 w. Mines & Min—April, 1906. No. 75964 C.

Extraction

Hydraulic Dredging. F. Danvers Power. Illustrates and describes this method of working alluvial ground, as practiced in Australia, stating its advantages. 1800 w. Eng & Min Jour—April 21, 1906. No. 76265.

Gold Dredges.

New Zealand Gold Dredges. Illustrated description of Watt & Nisbet's dredge-bucket system, and a dredge "Knewstubbs" system for the restoration of agricultural lands. 1000 w. Eng & Min Jour—April 14, 1906. No. 76056.

Idaho.

The Dollarhide Mine, Idaho. Arthur Lakes. Describes the topography of this region, and the location of the mine. The ore is silver bearing galena, mingled with rozin zinc blende and occasionally a little gray copper. 1600 w. Ills. Min Wld—April 7, 1906. No. 75977.

Mexico.

El Oro, the Premier Gold Camp of Mexico. T. Elliott Smith. Description and historical account of this mining region and its development. 4500 w. Min Wld—March 31, 1906. No. 75872.

Nevada.

The Geology and Petrography of the Goldfield Mining District, Nevada. Sketch maps with a description of the geology and topography by John B. Hastings, and of the petrography by Charles P. Berkey. 4500 w. Bul Am Inst of Min Engrs—March, 1906. No. 76124 C.

The Southern Klondike District. Esmeralda County, Nevada.—A Study in Metalliferous Quartz Veins of Magmatic Origin. Josiah Edward Spurr. Describes the occurrence in the Southern Klondike camp proper, giving detailed description of rock types, metalliferous veins, general conclusions, etc. 4300 w. Ec Geol—Feb., 1906. No. 75844 D.

Ore Treatment.

Milling vs. Smelting in the Treatment of Tonopah-Goldfield Ores. Francis L. Bosqui. Considers that these ores may be more profitably milled than smelted. 1000 w. Min & Sci Pr—March 31, 1906. No. 75973.

Slimes

Slime Treatment at Mount Bobby. John M. Bridge. Read before the Sydney Min. Engng. Soc. Describes the filter press method of treatment. Ills. 1500 w. Aust Min Stand—Feb. 28, 1906. Serial. 1st part. No. 76010 B.

Supply.

The Increasing Gold Supply. Editorial on the effect of the increasing sup-

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ply on the price of materials, cost of labor, and rates of interest. 1000 w. Mines & Min—April, 1906. No. 75969 C.

Tanks.

Iron vs. Wood for Cyanide Leaching Tanks. Francis L. Bosqui. States facts helpful in determining which type is best to use in a given locality. Also reports tests of redwood for the loss of gold by absorption. 900 w. Min & Sci Pr—April 14, 1906. No. 76177.

IRON AND STEEL.

Blast Furnaces.

Dust as a Cause of Wear in Shafts of Blast Furnaces (Gichtstaubals Ursache der Schachtzerstörung in Hochöfen). B. Osann. Notes on the corrosive and erosive action of dust upon furnace linings. 1500 w. Stahl u Eisen—March 15, 1906. No. 76228 D.

Interactions Between Iron and Carbon in the Blast Furnace. Discusses experimental investigations of the pressures and temperatures affecting the mutual actions of iron and its oxides with carbon and its oxides. 1000 w. Engng—April 13, 1906. No. 76198 A.

The Determination of the Profiles of Blast Furnaces (Die Berechnung des Hochofenprofils und ihre Grundlegenden Werte). Bernard Osann. A study of the principles governing the shape of the shafts of blast furnaces according to the nature of the ore and method of working. 4000 w. Stahl u Eisen—April 15, 1906. No. 76245 D.

Classification.

The Classification of Iron by its Molecular Structure (Ueber die Beurtielung des Eisens aus seinem Kleingefuge). Max Kralupper. A study of the effect of heat treatment upon the quality of iron, and the practicability of grading irons by metallographical methods. Serial. Part I. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 31, 1906. No. 76242 D.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Gas Firing.

The Kurzwernhart Gas-Saving Process. Joseph Hartshorne. Gives the results obtained from this process, together with the objections which have been urged against it, and the answers to them. Ills. 3800 w. Bul Am Inst of Min Engrs—March, 1906. No. 76119.

History.

The Early Use of Iron. Bennett H. Brough. Abstract of a lecture delivered before the West of Scotland Ir. & St. Inst. Gives a brief summary of the results of researches which have thrown light on this subject and reviews existing knowledge of the metallurgy of iron and steel before the introduction of the blast furnace. 1500 w. Ir & Coal Trds Rev—March 30, 1906. No. 76021 A.

Iron Ore.

Iron Ore Reserves. Charles Kenneth Leith. Discusses estimates that have been made of the world's supply of iron ore, its rate of depletion, etc. 2800 w. Ec Geol—Feb., 1906. No. 75843 D.

Iron Industry.

See Industrial Economy.

Metallography.

The Metallography of Iron in England. (Die Metallographie des Eisens in England). Dr. H. Wedding. A review of the work which has been done by British metallurgists and metallographists, with reproductions of microphotographs showing the different physical constituents of iron alloys. 3500 w. Stahl u Eisen—April 15, 1906. No. 76247 D.

Ontario.

Iron Ore in Ontario. Phillips Thompson. Notes from reports dealing with different areas where iron ore is known to occur, describing the deposits. 1800 w. Eng & Min Jour—April 14, 1906. No. 76057.

Phosphoric Irons.

On the Manufacture of a High-Class Steel from Phosphoric Irons. William Galbraith. Discusses the possibility of making a high-class steel from these ores by some modification of the basic process. 1300 w. Ir & Coal Trds Rev—March 23, 1906. No. 75914 A.

Rolling Mills.

Jones & Laughlin New No. 14 Structural Mill. Description, fully illustrated, of the largest rolling mill in the world, and an account of its rapid construction at Pittsburg. 2000 w. Ir Trd Rev—April 26, 1906. No. 76331.

Rolling Mill Drive Construction. Illustrations of old and new designs of pinions, spindles, couplings, etc., reproduced from an article by H. Ortmann in *Stahl und Eisen*. 1700 w. Ir Age—April 12, 1906. No. 76022 A.

Steel

Uses of Steel Versus Wrought Iron. Thomas Lace. Favors the use of open-hearth steel and calls attention to the short-comings of wrought iron. 2500 w. Am Mfr—April 15, 1906. No. 75940.

Steel Works.

German Steel Works and Rolling Mills. Henry Crowe. Abstract of a paper read before the Cleveland Inst. of Engrs. Short descriptions of various works visited. 2500 w. Ir & Coal Trds Rev—April 13, 1906. Serial. 1st part. No. 76310 A.

See also Mechanical Engineering, Materials.

MINING.

Accidents.

Catastrophes and Accidents in Mines

(Les Catastrophes et Accidents de Mines). H. Schmerber. A study of causes of the various kinds of disasters in mining operations, with possible warnings and methods of fighting them; with especial reference to the disaster at the Courrières colliery. 3500 w. Génie Civil—March 31, 1906. No. 76218 D.

Bore Holes.

The Alignment of Deep Bore Holes (Ueber Tiefbohrlochs-Lotapparate). F. Freise. Describing electrical and mechanical devices for insuring the maintenance of the vertical direction in drilling deep bore holes for mining and prospecting work. Serial. Part 1. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 7, 1906. No. 76244 D.

Disaster.

The Courrières Mine Disaster (Das Grubenunglück von Courrières). Fritz Schreyer. A general account of the catastrophe of the Courrières mine, discussing the conditions leading to the flow of gas and consequent explosion. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 7, 1906. No. 76243 D.

Drilling.

The Relative Merits of Large and Small Drilling-Machines in Development Work. Frederick F. Williams. Discusses the relative merits of the large 3⅛-inch. machine and the small 2¼-in. tappett machine in driving development-headings. 1500 w. Bul Am Inst of Min Engrs—March, 1906. No. 76123.

Earth Temperatures.

Earth Temperatures on the Witwatersrand Goldfields. Hugh F. Marriott. Abstract of a paper read before the Inst. of Min. & Met. A record of an investigation of earth temperatures and their relation to deep coal mining in the locality. 2200 w. Col Guard—March 23, 1906. No. 75904 A.

Firedamp.

A Study of Firedamp and the Protection of Electric Machinery. (Versuche mit Schlagwettern und dem Schlagwetternschutz Elektrischer Antriebe). Dr. H. Hoffman. A review of the investigations of Baum, Beyling, and others, upon the best methods of preventing the ignition of mine gases from electric machinery. Two articles—8000 w. Zeitschr d Ver Deutscher Ing—March 24, 31, 1906. No. 76201 each D.

Garnet Zones.

On the Formation of Garnet Zones at the Contacts of Eruptive Rocks and Limestones. James F. Kemp. A study of these zones, explaining the essential points which geologists have worked out regarding them. 3500 w. Min & Sci Pr—March 31, 1906. No. 75974.

Hauling.

European Mining Locomotives. Frank C. Perkins. Illustrations and descriptions of some types of electric, compressed air, and gasoline locomotives for use in mines. 1200 w. Mines & Min—April, 1906. No. 75965 C.

The Operation of Mine Locomotives (Betriebsergebnisse bei den Vörderung mit Gruben lokomotiven). S. Schauberger. Describing the use of gasoline and compressed-air locomotives for underground hauling, with data as to the cost of operation. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 31, 1906. No. 76241 D.

Head-Frames.

Head-Frames. W. R. Crane. On the principles of construction as illustrated by frames constructed at various mines. Ills. Gives also a list of papers and illustrations of head-frames and tipples, and a table of data. 4500 w. Mines & Min—April, 1906. No. 75968 C.

Mine Fires.

Extinguishing a Mine Fire. Lewis T. Wright. An address delivered before the Mining Conference describing a fire occurring in the Iron Mountain mine, Shasta County, California, and how it was extinguished. 1500 w. Cal Jour of Tech—Feb., 1906. No. 75960 C.

Natal.

Natal's Mineral Prospects. Ralph Stokes. Reviews the condition of the mining industry, reporting the output of coal, and unimportant deposits of gold and of copper. 2000 w. Min Wld—April 7, 1906. No. 75978.

Pumps.

Compressed Air Pumps with Water-Heated Reheater. L. C. Bayles. Illustrates and describes an improvement made at the Givern mine, California. 500 w. Eng & Min Jour—April 21, 1906. No. 76161.

Rock Drills.

Air-Hammer Rock Drills. E. A. Rix. Read at Convention of California Miners' Assn. Describes a new type of rock drill for mining work, the kinds of work to which they are suited, and results. 5000 w. Mines & Min—April, 1906. No. 75967 C.

Safety Device.

The Nicholson Automatic Engine-Stop. R. H. Nicholson. Illustrates and describes a mechanical arrangement to prevent overwinding. 900 w. Eng & Min Jour—April 21, 1906. No. 76163.

Shafts.

Notes on the Sinking of a Deep-Level Shaft. F. W. Girdler-Brown. Gives figures covering the cost of a deep level shaft, briefly discussing the rationale of some of the methods employed. 4 schedules. 4800 w. Jour S African Assn of Engrs—Feb. 3, 1906. No. 75939 F.

Re-Sinking and Repairing a Collapsed

We supply copies of these articles. See page 477.

Shaft. E. Nelson. Read before the Nat. Assn. of Colliery Mgrs. Illustrates and describes the methods employed to overcome the difficulties. 2000 w. Ir & Coal Trds Rev—March 30, 1906. No. 76020 A.

Silesia.

Mining and Railway Development in Upper Silesia (Bergbau und Eisenbahnen in Oberschlesien). Ober-Baurat Nitschmann. With map of the coal district and a general railroad and mining map. Silesia is rich in coal, iron, lead zinc, and silver. Discussion. 3500 w. Glasers Annalen—April 15, 1906. No. 76260 D.

Snowslides.

Snowslides in the Mining Districts of Idaho. Prof. Arthur Lakes. Discusses their causes and disastrous effects, and how to avoid them. Ills. 2000 w. Mines & Min—April, 1906. No. 75966 C.

The Effect of a Snowslide. Stephen L. Goodale. An illustrated account of the snowslide on March 17, 1906, which demolished a large portion of the stamp-mill of the Camp Bird, at Ouray, Colo. 700 w. Min & Sci Pr—April 14, 1906. No. 76178.

Tunnels.

The Newhouse Tunnel. George W. Dutton. A description, with illustrations, and general information concerning this work. 1600 w. Min Wld—April 21, 1906. No. 76180.

Winding.

Electric Main Winding Plant for a Shale Mine. Illustrated description of a plant at Cobbinshaw pit, about 15 miles from Edinburgh. 2000 w. Engng—March 30, 1906. No. 76014 A.

Electric Winding Considered Practically and Commercially. Gerald Hoogwinkel. Abstract of a paper read before the Newcastle Sec. of the Inst. of Elec. Engrs. A contribution to the discussion of the paper by W. C. Mountain. Also general discussion. 6000 w. Col Guard—March 23, 1906. Serial. 1st part. No. 75903 A.

Over-Winding in Hoisting Operations. Robert Peele. Explains the dangers from over-winding, and discusses the various devices which have been introduced to prevent fatal consequences. Ills. 3800 w. Sch of Mines Rev—Jan., 1906. No. 76385 D.

The Development of Hoisting Appliances (Entwicklung der Aufsetzvornichtungen). Karl Teiwes. Discussing especially the appliances used in connection with mine hoists for controlling the exact landing position of the cage or platform. 6000 w. Glückauf—March 31, 1906. No. 76240 D.

Winding Ropes. Editorial considering some of the inquiries in regard to winding ropes made by a Commission appointed by the Transvaal Government to report on the question of safety of persons traveling in shafts. 6800 w. Min Jour—March 24, 1906. No. 75906 A.

MISCELLANY.

Lead and Zinc.

Lead and Zinc Deposits of the Virginia-Tennessee Region. Thomas Leonard Watson. A summary of the results obtained from a study of the geology of the ore-deposits of this district. 13800 w. Ills. Bul Am Inst of Min Engrs—March, 1906. No. 76117 D.

Manganese.

The Principal Manganese Deposits of the World (Les Principaux Gisements de Manganèse du Globe). Ch. Dantin. A review of the manganese deposits in various parts of the world, with the constitution of the minerals and estimates of the quantities. 2000 w. Génie Civil—March 24, 1906. No. 76215 D.

Mercury.

The Mercury Mining District of Monte Amiata, Italy. Vincenzo Spirek. Gives the location and describes the deposits, method of working, production, treatment, etc. Ills. 5000 w. Min Mag—April, 1906. No. 76040 C.

Ores.

Sedi-Genetic and Ignes-Genetic Ores. H. Foster Bain. An investigation aiming to obtain a quantitative estimate of the relative importance in ore production of certain major groups of processes. 2800 w. Ec Geol—Feb., 1906. No. 75841 D.

Petroleum.

The Boulder Oil Fields. A. Lakes. Describes this field explaining why this small area is productive, while the same shales at other points never yield a commercial amount. 1200 w. Min Rept—March 29, 1906. No. 75870.

Platinum.

The Best Riffle for Platinum. Dennis H. Stovall. Considers the best riffle for the tailing-flume is steel strapped scantlings. 800 w. Min & Sci Pr—April 7, 1906. No. 76059.

Tin.

Tin Mining and Milling in Tringganu. C. C. Warnford Lock. An illustrated account of the tin mining of Malay peninsula describing the geology of the region, the tin deposits, etc. 1400 w. Min Mag—April, 1906. No. 76041 C.

Zinc.

The Mining, Preparation and Smelting of Virginia Zinc-Ores. Thomas Leonard Watson. Treats of the purely economic phases of the zinc ores of this district. 4500 w. Ills. Bul Am Inst of Min Engrs—March, 1906. No. 76118.

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CONDUCTING TRANSPORTATION.

Accidents.

Accidents to Servants on American and British Railways. A comparison showing much better conditions in England than in America. 2400 w. Engr, Lond—March 30, 1906. No. 76017 A.

Floods.

Flood Damages, N. W. R., India. G. H. List. An illustrated account of some of the railway disasters caused by floods, especially describing the destruction of the Pulku-Nala bridge. 1800 w. Engr, Lond—April 6, 1906. No. 76083 A.

Gould Railways.

The Gould System. Gives a brief outline of the history prior to 1901, and treats in greater detail the events of the last five years, showing the development, and discussing the outlook. 2200 w. R R Gaz—April 20, 1906. No. 76149.

Standard Code.

Suggested Changes in the Standard Code. H. A. Dalby. Gives suggestions with explanations of why the changes are recommended. 5500 w. Ry Age—March 30, 1906. No. 75868.

Train Control.

The Powell-Potter System of Automatic Control of Trains. Benton C. Rowell. From an address before the Nat. Assn. of Ry. Com., at Washington. An explanation of the system and its operation. 7000 w. Ry & Engng Rev—April 7, 1906. No. 75976.

MOTIVE POWER AND EQUIPMENT.

Boiler.

Riegel Water Tube Locomotive Boiler. Illustrates and describes a new design. 1200 w. Am Engr & R R Jour—April, 1906. No. 75851 C.

Brakes.

Advancement and Improvements in Air-Brakes. Walter V. Turner. Abstract of a paper read before the Cent. Elec. Ry. Assn. Aims to show that improvements in the system have kept pace with the development of locomotion. Explains some features introduced. 3500 w. St Ry Rev—April 15, 1906. No. 76063 C.

Kapteyn's Apparatus for Testing Continuous Brakes (Kapteyn's Prüfvorrichtung für Versuche mit Durchgehenden Bremsen). A. Führ. The successive action of the brake cylinders is recorded by pressure indicators on a moving band of paper. 2000 w. Glasers Annalen—April 1, 1906. No. 76259 D.

Test of the Sauage Air Brake. George L. Fowler. Illustrates and describes this arrangement and its action, reporting the tests made. 5500 w. R R Gaz—April 6, 1906. No. 75956.

Cars.

The Six-Axle Cars of the International Sleeping-Car Company (Voitures à Six Essieux de la Compagnie Internationale des Wagons-Lits). Illustrating the new dining cars and compartment sleeping cars of the International Company, fitted with six-wheel bogie trucks at each end. Special details of the trucks are shown. 1800 w. 1 plate. Génie Civil—March 31, 1906. No. 76216 D.

Car Department Control. F. Lincoln Hutchins. Discusses the fundamentals of car department management, how to make the records, and how to make them show the actual performance. 3500 w. Ry Age—April 20, 1906. No. 76168.

The Betts Car Reporting System. Describes this new system used in making up accurate car records, recently installed in the Chicago North-Western Ry. Gives blanks used. 1200 w. R R Gaz—April 27, 1906. No. 76379.

Third-Class Carriage for the Belgian State Railways. Illustrated description. 600 w. Engng—April 6, 1906. No. 76079 A.

Electric Traction.

See Street and Electric Railways.

Explosion.

Explosion of a Locomotive Boiler near the Saint-Lazare Station, Paris. Robert Dubois. Gives general information, description of the engine, and methods of investigation, with many illustrations. 6800 w. Bul Int Ry Cong—March, 1906. No. 76361 E.

Liquid Fuel.

Locomotive Firing with Liquid Fuel. A. S. Atkinson. Describes the arrangements for the general use of oil as a fuel in Southern California, and discusses the important factors favoring the use of oil for locomotive firing. 2500 w. Boiler Maker—April, 1906. No. 75991.

Locomotive Failures.

A Ten Years' Record of Locomotive Failure. Gives some results of a careful study made of locomotive casualties on an English road, covering ten years. 1500 w. Am Engr & R R Jour—April, 1906. No. 75854 C.

Locomotives.

Consolidation Locomotive for the Boston & Maine. Illustrations, principal dimensions, and particulars of 2-8-0 locomotives with Walschaert valve gear. 300 w. Ry Age—April 20, 1906. No. 76167.

Culm Burner for the D., L. & W. Il-

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lustrated description of engines with the Wootten type of wide firebox. 600 w. Ry & Loc Engng—May, 1906. No. 76376 C.

Details of the A. C-D. C. Locomotives for the New York, New Haven & Hartford Railroad. Describes the electric locomotives for operation on the direct-current division between the Grand Central station and Woodlawn, and on the alternating-current portion of its line between Woodlawn and Stamford. Ills. 3000 w. R R Gaz—April 13, 1906. No. 76046.

First Swedish Superheater Locomotive. Dr. Alfred Gradenwitz. Brief illustrated description of the type of apparatus used, and a record of some comparative trials. 1000 w. Ry Age—April 20, 1906. No. 76170.

Mallet Compound Duplex Locomotives for the Guayaquil & Quito Railway. Illustrations with dimensions and notes. 500 w. Eng News—April 12, 1906. No. 76052.

New Atlantic-Type Locomotives. Photograph and particulars of new Atlantic (4-4-2) type express passenger locomotives for the London, Brighton, and South Coast Ry. 700 w. Mech Engr—March 31, 1906. No. 76002 A.

New Compound Express Locomotives; Midland Railway. Charles S. Lake. Illustration, principal dimensions, and particulars of interest. 800 w. Mech Engr—April 7, 1906. No. 76070 A.

Pacific Type Passenger Locomotive. Illustrates and describes some powerful locomotives built for the Southern Railway. 500 w. Am Engr & R R Jour—April, 1906. No. 75853 C.

Recent High-Speed German Locomotives (Neuere Deutsche Schnellzuglokomotiven). M. Michter. Discussing especially the modern four-cylinder compound engine of the de Glehn type, with diagrams of speed performance. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—April 14, 1906. No. 76208 D.

Score: 84 Not Out. Illustrated description of an engine, still at work on the Northeastern Railway of England, which was built in 1822. 1000 w. Ry & Loc Engng—April, 1906. No. 76023 C.

Single Expansion 4-6-2 for the O. S. L. Illustrated description of a Prairie type engine for the Oregon Short-Line. 700 w. Ry & Loc Engng—May, 1906. No. 76373 C.

Ten-Wheel Freight Locomotive for James Bay Railway. Illustration with description of the special features. 1000 w. Can Engr—April, 1906. No. 75921.

The Actual Efficiency of a Modern Locomotive Represented by Work Actually Performed, Compared with the Lighter Locomotives, of Twenty Years Ago. Willian Penn Evans. A comparison between the locomotives of the present and those built twenty years ago, as to efficiency, cost, reliability, etc. 5000 w. Pro Pacific C Ry Club—Feb. 17, 1906. No. 75924 C.

The Cole Four-Cylinder Balanced Compound. G. M. Basford. Reviews an interesting line of development of passenger locomotives showing the progress toward very powerful engines and in the Cole four-cylinder Compound, with illustrations. The advantages of the compound are stated and of balancing. 9000 w. Pro S & S-W Ry Club—Jan., 1906. No. 76093 E.

The Large Locomotive. G. M. Basford. Remarks on the rapid advance in weight and power, their service, efficiency, maintenance, etc. 5000 w. Pro Pacific C Ry Club—Feb. 17, 1906. No. 75925 C.

The latest Great Northern Engines. Charles Rous-Marten. A report of actual work done by these Ivatt locomotives, a compound, and two non-compounds. 2500 w. Engr, Lond—March 31, 1906. Serial. 1st part. No. 76016 A.

The Mellin Compound. Hal R. Stafford. An illustrated description of this two-cylinder compound in its latest form with an outline of the history of this type. 2000 w. Am Engr & R R Jour—April, 1906. No. 75850 C.

Locomotive Tests.

Report of Committee Appointed to Cooperate with the Pennsylvania Railroad System in Conducting Tests of Locomotives at the Louisiana Purchase Exposition. 7200 w. Am Soc Mech Engrs, No. 092—May, 1906. No. 76103 C.

Motor Cars.

Railway Automobiles (Motorlokomotiven). F. Kramer. With illustrations of gasoline and petroleum automobile cars for use on railways, with especial reference to the machines of the Otto works at Deutz, opposite Cologne. 4000 w. Zeitschr d Ver Deutscher Ing—April 7, 1906. No. 76205 D.

Pipe Connections.

Diagram of Pipe Connections—"E T" Engine and Tender Equipment. Gives illustrations showing the pipe connections and the internal construction of the various valves, with descriptive notes of the working. 2500 w. Ry & Loc Engng—April, 1906. No. 76024 C.

Power House.

See Electrical Engineering, Generating Stations.

Stay-Bolts.

Stay-Bolt Practice of the Pennsylvania Railroad. Illustrates and describes improvements introduced by A. W. Epright, giving results. 1700 w. Am Mach—Vol. 29. No. 13. No. 75861.

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Tractive Power.

Some Slippery Engines. Editorial, explaining the causes of slipping, and showing that, while sometimes the result of design, is always caused when the maximum tractive effort exceeds the frictional limit. 1500 w. Ry & Loc Engng—May, 1906. No. 76374 C.

Valves.

Distributing Valve. Illustrated description of these valves, the internal construction and operation in air brakes. 3000 w. Ry & Loc Engng—May, 1906. No. 76375 C.

NEW PROJECTS.

Alaska.

The Alaska Central Railway. M. S. Duffield. An illustrated article describing the railroad building across Kenai peninsula, and the proposed extension; the character of the country, and matters of interest in regard to its development. 3000 w. Eng & Min Jour—April 21, 1906. No. 76164.

Cuba.

The Railroads of Cuba. An illlustrated description of the railroad system, and account of the companies operating the lines. 1200 w. R R Gaz—April 20, 1906. No. 76154.

Mexico.

The New Railroad for the West Coast of Mexico. E. A. H. Tays. Map and information concerning a railroad to be built from Guaymas, Sonora, southward, probably terminating at Tepic. 3000 w. Eng & Min Jour—April 7, 1906. No. 75997.

PERMANENT WAY AND BUILDINGS.

Coaling Plant.

The Watscka Coal, Ash and Water Plant of the Chicago & Eastern Illinois R.R. A recently built plant, having a number of advantageous features is illustrated and described. 1500 w. Eng Rec—April 14, 1906. No. 76318.

Construction Work.

Construction Work on the Canadian Northwestern Railway System. An illustrated description of the building of this railway, especially the construction work during the past season. 3000 w. Eng News—April 5, 1906. No. 75946.

Curves.

Line and Surface. Moses Burpee. This first of a series of articles, explains the principles governing the properties of curves. 1800 w. Ry & Engng Rev—April 21, 1906. Serial. 1st Part. No. 76171.

Gauges.

The Gauge of Colonial Railways. Information concerning the gauges used in Australia, India and South Africa. 2700 w. Engr, Lond—April 13, 1906. No. 76309 A.

Key West Extension.

Key West Extension of the Florida East Coast. Harry C. Smith. An illustrated article describing the progress and explaining some of the difficulties. 1800 w. R R Gaz—April 20, 1906. No. 76152.

Rail Joint.

Improved Rail Joint for Street Railways (Neue Schienenstossverbindungen für Strassenbahnen). W. Küppers. Describing a form of joint in which an intermediate headpiece of rail is inserted. A portable milling machine is used to finish off the surface of the joint. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—April 6, 1906. No. 76226 D.

Shops.

New Shops of the Missouri, Kansas & Texas Railway, Parsons, Kansas. Illustrates and describes the new plant under construction for repair facilities. 900 w. Ry Age—April 13, 1906. No. 76068.

Signalling.

Automatic Signals in Great Britain and on the Continent. Interesting information concerning the causes that have worked against the introduction of automatic systems. 2500 w. Ry Age—April 20, 1906. No. 76169.

Blake Signals: Their Operation and Uses. E. J. Burke. Abstract of a paper read before the Cent. Elec. Ry. Assn. Explains the uses in detail, and gives general information in regard to the system. 2000 w. St Ry Rev—April 15, 1906 No. 76062 C.

Switches.

The Arrangement of Switches on American Railways (Die Weichen Amerikanischer Eisenbahnen). Dr. Blum & E Giese. Notes of inspection on American railways, with illustrations of switches and frogs used on the Pennsylvania, New York Central, and Illinois Central railroads. 2500 w. Zeitschr d Ver Deutscher Ing—March 17, 1906. No. 76200 D.

Switzerland.

The Davos - Filisur Railway (Die Bahnlime Davos-Filisur). P. Saluz. A description of the new line to connect the Rhaetikon Railway with the interior of the Engardine. Map and profile are given, and details of bridges. 1600 w. Schweiz Bauzeitung—March 24, 1906. No. 76249 B.

Tehuantepec.

The Isthmus of Tehuantepec and Its Inter-Ocean Railway. A report on the construction of a railway across this isthmus, and its possible relation to the Panama Canal. Ills. 2000 w. Sci Am Sup—April 7, 1906. No. 75928.

Terminals.

Railway Terminals on San Francisco Bay. Map, with explanation of the location and topography and the lines now built or under construction. Considers

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the terminals on the Oakland side of the bay, ferry systems across the bay, and the Southern Pacific terminals in San Francisco. 2000 w. Ry Age—April 20, 1906. No. 76166.

The Transformation of the Railway Station at Lausanne (La Transformation de la Gare de Lausanne). A description of the important extension of the Simplon-Jura station at Lausanne in view of the increased traffic expected upon the opening of the Simplon tunnel. 1500 w. 1 plate. Bull Tech de la Suisse Romande—March 10, 1906. No. 76265 D.

Ties.

Concrete Railroad Ties. G. H. Kimball. Considers the present status of the tie question, giving a practical example of a concrete tie that has withstood the test of time and traffic. Ills. 2000 w. Cement Age—April, 1906. No. 76029.

Metallic Cross Ties (Der Eiserne Oberbau). A review of the possibility of replacing wooden sleepers with some form of metallic tie which shall be commercially and structurally practicable. 3500 w. Stahl u Eisen—March 15, 1906. 76227 D.

Track.

The Deformations of Railway Track (Sur les Déformations des Voies de Chemins de Fer). G. Cuénot. A study of the influence of cross ties of different kinds upon the transversal, vertical and longitudinal movements of the rails. Experiments were made with sleepers of wood, steel, and steel and wood combined. 1200 w. Comptes Rendus—March 26, 1906. No. 76222 D.

Tunneling.

See Civil Engineering, Construction.

Wabash.

Wabash Eastern Improvements. An illustrated article describing improvements at the Wabash-Pittsburg terminal, and at Jewett, Ohio, where the connection is made with the Wheeling & Lake Erie, and other points. 1800 w. R R Gaz—April 27, 1906. No. 76378.

TRAFFIC.

Railroad Rates.

See Industrial Economy.

Statistics.

Traffic Statistics and Freight Train Working. Considers statistics from the working point of view, aiming to show the difficulties in their application, the best methods of handling them, and in what directions improvements may be made. 4000 w. Ir & Coal Trds Rev—March 30, 1906. No. 76019 A.

STREET AND ELECTRIC RAILWAYS

Baltimore

The Reconstructed Baltimore System. An illustrated account of the damage to the system by the fire in Feb., 1904, and the work accomplished in the past two years, which has greatly improved the property and increased its efficiency. 3300 w. St Ry. Jour—April 21, 1906. No. 76172 C.

Berlin.

Plans for Reducing the Headway between Trains on the Berlin City Railway (Vorschlage zur Verkürzung der Zugfolgezeit auf des Berliner Stadbahn). W. Wechmann. A discussion of traffic conditions on the Berlin elevated railway, with speed curves and signal systems, showing how the carrying capacity may be increased. 4000 w. Glasers Annalen—April 15, 1906. No. 76261 D.

Boston Subway.

The Washington St. Tunnel of the Boston Subway System. A report of the construction of this new tunnel for the accommodation of the elevated trains. Ills. 4500 w. Eng News—April 19, 1906. No. 76130.

Cable Incline.

The Electric Cable Road at Nancy (Funiculaire Electrique de Nancy). G. E. Bernardet. Describing a cable incline railway from the city of Nancy to Saint Antoine, a resort about 150 feet above. The cable runs continuously driven by electric power, the number of cars being varied to meet the traffic. 4000 w. Mem Soc Ing Civ de France—Jan. 1906. No. 76233 G.

Car Wiring.

Good Wiring Practice on Cars at Washington, D. C. An illustrated description of the scheme of Gordon Campbell for furnishing maximum protection against damage to cars and injury to passengers from electrical causes. 600 w. St Ry Jour—April 21, 1906. No. 76173 C.

Chicago.

The Capacity of Surface Loops for Traffic as Influenced by the Intersecting Lines in the Downtown District of Chicago. W. A. Blanck. Report of an investigation showing that it is impossible to operate more cars on the loop under consideration with the present schedule of speed. 1600 w. St Ry Jour—April 14. 1906. No. 76065 C.

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Interurban.

Economic and Financial Phases of Interurban Railways. Guy Morrison Walker. Especially discussing the economic value of railways. 6000 w. Sib Jour of Engng—April, 1906. No. 76389 C.

London.

London Tube Railways Permanent Way. Drawings showing in detail the system in the Baker Street and Waterloo Railway, with explanatory notes. 800 w. R R Gaz—April 20, 1906. No. 76156.

Recent Extensions of the London United Tramways. Illustrated description of the recently opened Surrey extensions, which are the first tramways to cross a Thames bridge. 2200 w. Elec Rev, Lond—April 6, 1906. No. 76073 A.

Main Lines.

Alternating Current Electric System for Heavy Railway Service. B. G. Lamme. Discusses the development in the application of electricity to heavy service, and describes the New Haven single-phase equipment. Discussion follows. Ills. 34000 w. Pro N Y RR Club—March 16, 1906. No. 76091.

Electric Traction for Trunk Lines. Extracts from a report made by K de Kando, to Ganz & Co., on impressions received on his recent trip to America. 3500 w. R R Gaz—April 20, 1906. Serial. 1st part. No. 76155.

Electric Traction on Main Line Railways in Europe. Philip Dawson. A discussion of the electrification of main lines, explaining conditions, comparing the systems of operations available, describing details of equipment, and giving much information. Ills. 9500 w. St Ry Jour—April 7, 1906. No. 75989 C.

Power House.

See Electrical Engineering, Generating Stations.

Sand.

Drying Sand for Sanding Rails in the Borough of Manhattan. W. Boardman Reed. Explains the conditions which cause "bad" rails in the city, and the effects of coarse sand on the wheels and describes the screening and drying of the sharp fine sand used. Ills. 2800 w. St Ry Jour—March 31, 1906. No. 75874 C.

Simplon

Electric Traction on the Simplon Railway. Dr. Alfred Gradenwitz. Information concerning the arrangements being made for the trial runs permitting a comparison between steam traction and electric service. 1000 w. Sci Am—April 7, 1906. No. 75926.

Single-Phase.

Experimental Single-Phase Installations for the Swedish State Railways. Gives a brief illustrated description of the trial equipments for the electric railway experiments in progress. 2000 w. St Ry Jour—March 31, 1906. No. 75873 C.

Single-Phase and Continuous-Current Equipments and Limiting Schedule Speeds. H. M. Hobart. Compares the merits of the two systems pointing out the importance of having ample reserve of capacity for maintaining high accelerating rates in order to obtain the improvement in schedule speed demanded. Diagrams. 2700 w. Tram & Ry Wld—April 5, 1906. No. 76139 B.

Single-Phase Direct-Current Locomotive for the New York, New Haven & Hartford Railroad. An illustrated account of the motor and its construction, with detailed description of this important machine and its operation. Also editorial. 6700 w. St Ry Jour—April 14, 1906. No. 76064 C.

Single-Phase Railway Motors and Methods of Controlling Them. T. H. Schoepf. Abstract of a paper read before the Manchester Local Sec. of the Inst. of Elec Engrs. Short discussion. 1700 w. Elect'n, Lond—March 23, 1906. No. 75902 A.

Subways.

New York Subway and George S. Rice's Views. Extract from an address by the Chief Engineer of the New York Rapid Transit Commission, delivered before the New England Railroad Club at Boston. Also discussion. 3800 w. R R Gaz—April 20, 1906—No. 76153.

The Philadelphia Subway. David Lay. Illustrates and describes new features in concrete construction, tracklaying, and sanitary arrangements. 1500 w. Cement Age—April, 1906. No. 76030.

Ventilating the New York Subway. Editorial review of the recent report of George S. Rice on the investigations of the ventilating problem. 1000 w. Eng Rec—April 7, 1906. No. 75980.

Third-Rail.

Effects of a Sleet-storm on Different Types of Third Rail Protection. Gives illustrations showing the sleet formation on the rail, with the various types of protection. 400 w. R R Gaz—April 13, 1906. No. 76047.

Third Rail Insulators. E. Goolding. Gives plan and sectional elevation of a new form of third rail insulator with descriptions. 1200 w. Tram & Ry Wld—April 5, 1906. No. 76140 B.

Ventilation.

The Condition of the Air of the Rapid Transit Subway. George A. Soper. Abstract of a paper presented before the N. Y. Acad. of Medicine. Reports concerning the temperature, humidity, bacteria, sanitation, dust, and odors. 4000 w. St Ry Jour—March 31, 1906. No. 75875 C.

We supply copies of these articles. See page 477.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves readv to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer. *w.* Pittsburg.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A
Locomotive. *m.* Hartford. U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *s-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U.S.A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal..
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Instituts Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

History.

Morton Memorial—A History of the Stevens Institute of Technology, Edited by Franklin de Ronde Furman, with an introduction by President Alexander Crombie Humphreys. Size 8 in. by 12 in.; pp. xxiv 641. Price $10. Hoboken, N. J.: Stevens Institute of Technology.

This magnificent volume was originally started by the late President Morton some years before his death with the intention of making it a souvenir of the twenty-fifth anniversary of the founding of Stevens Institute. After the death of President Morton the work was taken in hand by the alumni of the Institute, the plan being so modified as to render it, a memorial to Dr. Morton, as well as a history of the Institute, and in this form it has been completed and issued to such members of the alumni as had subscribed for it.

There being a moderate excess of copies beyond the number necessary to supply the subscribers the committee has decided to offer the remainder of the edition for public sale, so that it has become practicable for a limited number of copies to be placed in the hands of those to whom it would otherwise have been inaccessible, and we believe that we are fully justified in stating that this opportunity will be welcomed to the fullest extent.

The first portion of the book includes a history of Stevens Institute of Technology from its foundation in 1870 to the year 1905, including the construction of the original building and the formation of the original faculty, together with the changes and additions which have been made since that time, including the Carnegie laboratory, and its endowment. This is followed by an account of the engineering achievements of the various members of the Stevens family, covering especially the work of John, Robert L., and Edwin A. Stevens. This section contains much original matter covering the early days of the steamboat, operated by John Stevens on the Hudson River in 1804, and on the ocean for the first time in 1809 by Robert L. Stevens; the steam railroad, operated on a private track in Hoboken in 1826 by John Stevens and in public service as the Camden & Amboy, in 1831; the armored war vessel; and many mechanical devices, such as the present form of rail and spike used on American railroads; the screw propeller; the multitubular boiler; the use of steam expansively, of anthracite coal in locomotives, and many other inventions.

The third section includes biographies of the trustees, faculty, and alumni of Stevens Institute, including complete lists of the writings of Dr. Morton, Professor Thurston, and other eminent members of the faculty. In the biographies of the alumni every graduate is included, with portraits of nearly one-half the number, and many interesting facts about the careers of the men after their graduation.

This work is a most valuable contribution to the engineering history of the United States during the past quarter-century, showing the important part which the graduates of Stevens have taken in the development of the applied science of engineering in all parts of the land, and a copy should be in every important reference library in the country.

Valve-Gears.

Valves and Valve-Gear Mechanisms. By W. E. Dalby. Size 6½ in. by 10 in., pp. xii, 366. Price 21 shillings. London: Edward Arnold. New York: Longmans, Green & Co.

Valve Gears for Steam Engines. By Cecil H. Peabody. Size 6 in. by 9 in., pp. v, 142. Price $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

It is interesting that Professor Dalby's extensive treatise of steam-engine valve-gears should appear about the same time as a new and revised edition of Professor Peabody's book upon the same subject,

and it may be appropriate to notice them at the same time.

As Professor Dalby says in his preface, valve-gear mechanisms have fascinated successive generations of engineers, and yet we have at the present time in practical use three or four groups of such mechanisms upon which engineers have settled as best adapted for steam engines of corresponding types. For stationary engines either the slide valve with its eccentric, or some form of trip or detached valve-gear, is applied; for locomotives either the ordinary link or the Walschaert; and for marine engines the link, or some one of the radial gears; these are the practical departments into which valve gear-design is found to be divided, and this condition of affairs will probably continue to obtain until reciprocating engines are replaced altogether by turbines or other rotating machines, or steam is supplanted by gas.

Professor Dalby limits himself in the present volume to those gears in which there is one, and only one position of the valve for a given position of the crank, thus excluding all of the so-called "detached" gears from analytic discussion, although in a chapter entitled "Independent Valve Gears" a brief description is given of the Meyer, Rider, Corliss, and Sulzer gears. After preliminary chapters, in which the general construction of valves and their operation by a single eccentric are discussed by graphical methods there follows an analytic summary, after which reversing valve gears are treated, following generally the method of Zeuner, but employing the rectangular diagram of Professor Osborne Reynolds. In a chapter on radial gears the Walschaert gear is given particular attention, this being especially welcome in view of the fact that this excellent gear has practically displaced the link motion entirely on the Continent for locomotives, and is rapidly coming into use for the outside cylinders of modern four-cylinder compound engines in England and America.

A very useful chapter is that upon statical and dynamical problems in connection with the design of a valve gear, the increasing dimensions, weights, and speeds in modern practice rendering these points of great importance, especially in connection with valve gears for marine engines.

The text book of Professor Peabody is naturally prepared from a different viewpoint from the preceding volume, being intended rather to give the learner a firm grasp of the principles, together with facility in their application, than to provide a comprehensive mathematical discussion of the whole subject. The Zeuner diagram is used throughout, and analytical discussions are relegated to an appendix.

In the discussion of radial valve gears, Professor Peabody believes that such large irregularities occur in their motions that analytical methods are useless, if not misleading, and instead of endeavoring to give a general method of treatment he confines himself to the direct discussion of a few prominent forms, stating that facility in the design of such motions can be obtained only through experience, an opinion which commends itself to common sense and judgment.

A useful chapter in Professor Peabody's book is that relating to the design of gears with shifting eccentrics, this including the methods used in a number of the so-called single-valve automatic engines which, in the United States at least, form a commercially important portion of the steam engine business. The chapter on drop cut-off valve gears contains a discussion of the Corliss gear of the Reynolds type, together with some treatment of cam gears as used by several American builders.

The illustrations in Professor Peabody's book are all in the form of folding plates, placed in the back of the book, and so arranged that when unfolded the entire illustration may be seen while referring to any portion of the book. This plan, which has its advantages, does not render the volume convenient for general consultation, especially when, as in this instance there are no titles on the plates, other than a reference number.

Biography.

Automobile Biographies. Edited by Lyman Horace Weeks. Size 6 in. by 9 in., pp. 180. Price $2.00. New York: The Monograph Press.

The development of the automobile some time ago reached a stage where the identity of the men engaged in the work became a matter of public interest, and the compilation of this book has met this feeling by providing a series of short biographies of those who have done good work in the design and introduction of mechanically-propelled vehicles. The first portion of the volume relates to the origin and development of the automobile, including the early steam vehicles which preceded and accompanied the development of the railroad, this being followed by a series of biographies, beginning with Cugnot and coming down to Daimler, Levassor, and Serpollet. Many excellent portraits accompany these short sketches, giving a good idea of the personality of the men, while appended is a list of brief notes concerning noted investigators whose work has aided in the development of the automobile